EPA/ROD/R04-05/035
2005

EPA Superfund
Record of Decision:

OAK RIDGE RESERVATION (USDOE)
EPA ID: TN1890090003
OU 15
OAK RIDGE, TN
04/19/2005

D4-15

DOE/OR/01-2161&D2

Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee

This document is approved for public release per review by:

M. W. Davis /dw 3/3/2005

BJC ETTP Classification & Information Office | Date

10115981

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

DOE/OR/01-2161& D2

Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee

Date Issued - March 2005

Prepared for the
U. S. Department of Energy
Office of Environmental Management

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant Portsmouth Gaseous Diffusion Plant
under contracts DE-AC05-98OR22700 and DE-AC05-030R22980
for the
U.S. DEPARTMENT OF ENERGY

PREFACE

This *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161& D2) was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, to present the public with the selected remedy for environmental remediation of contaminated areas within Zone 2. This Record of Decision (ROD) documents the selected remedy agreed on by the U.S. Department of Energy (DOE), the Tennessee Department of Environment and Conservation, and the U.S. Environmental Protection Agency. This remedy addresses the inactive units, contaminated soil, and other contaminated material within Zone 2 of the East Tennessee Technology Park. This decision is supported by scientific studies and other pre-decisional documents that are contained in the Administrative Record file for this project. Following are the principal documents supporting this ROD:

- *Phase 2 Remedial Investigation/Baseline Risk Assessment Report and Feasibility Study for the K-1070-C/D Classified Burial Ground at the Oak Ridge K-25 Site, Oak Ridge, Tennessee* (DOE 1995);

- (draft) *Remedial Investigation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 1999a);

- *Focused Feasibility Study for Zone 2 Soils and Buried Waste, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2004a) [including the Addendum (DOE 2004b)]; and

- *Proposed Plan for Contaminated Soil, Buried Waste, and Subsurface Structures in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2004c).

These documents and other information supporting the selected remedial action can be found at the DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge, TN 37830, (865) 241-4780.

CONTENTS

FIGURES

TABLES

ACRONYMS

AM	Action Memorandum
ARAR	applicable or relevant and appropriate requirement
AT123D	Analytical Transient 1-, 2-, 3-Dimensional (model)
bgs	below ground surface
BJC	Bechtel Jacobs Company, LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CNF	Central Neutralization Facility
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
D&D	decontamination and decommissioning
DCE	dichloroethene
DNAPL	dense, nonaqueous-phase liquid
DOE	U.S. Department of Energy
DQO	data quality objective
ELCR	excess lifetime cancer risk
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ETTP	East Tennessee Technology Park
EU	exposure unit
EUWG	End Use Working Group
FFA	Federal Facility Agreement
FFS	focused feasibility study
FS	feasibility study
FY	fiscal year
GRA	general response action
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
IRIS	Integrated Risk Information System
LMES	Lockheed Martin Energy Systems, Inc.
LUC	land use control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MCL	maximum contaminant level
MMES	Martin Marietta Energy Systems, Inc.
MOU	Memorandum of Understanding
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act of 1969 NPL National Priorities List
O&M	operation and maintenance
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation

ORSSAB	Oak Ridge Site Specific Advisory Board
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	preliminary remediation goal
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	Resource Conservation and Recovery Act of 1976
RDR	Remedial Design Report
RER	Remediation Effectiveness Report
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthonzation Act of 1986
SD	storm drain
SESOIL	Seasonal Soil (compartment) model
SSAB	Site Specific Advisory Board
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCA	trichloroethane
TCE	tnchloroethene
TDEC	Tennessee Department of Environment and Conservation
UCL_{95}	95% upper confidence limit
UF_6	uranium hexafluoride
UST	underground storage tank
VOC	volatile organic compound
WAC	waste acceptance criteria

1.1 SITE NAME AND LOCATION

Zone 2 at East Tennessee Technology Park
Oak Ridge Reservation
Oak Ridge, Tennessee
CERCLA Information System ID TN #1890090003

1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedy for environmental remediation of contaminated areas within Zone 2 of East Tennessee Technology Park (ETTP), formerly the K-25 Site and the Oak Ridge Gaseous Diffusion Plant (ORGDP), on the U.S. Department of Energy's (DOE's), Oak Ridge Reservation (ORR) in Oak Ridge, Tennessee. The remedy specifically addresses contaminated soil, buried waste, and subsurface structures (including slabs). The decision establishes remediation levels to protect future users of the site and to protect underlying groundwater. This ROD does not include actions to address previously contaminated groundwater, surface water, or sediment, nor does it include actions to address impacts on terrestrial ecological receptors. These actions will result from the future Site-wide ETTP decision for residual contamination.

The decisions in this ROD apply to the 800-acre area designated as Zone 2 at ETTP. This area has had heavy industrial use and includes the main plant, laboratory, administration, and disposal areas, as well as maintenance shops and support facilities for the former plant. Environmental remediation consists primarily of removal of existing contamination. Land use controls (LUCs) are selected to ensure that residual contamination remaining after completion of response actions does not pose a short- or long-term threat to human health.

The Zone 2 remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA) [42 *United States Code* Section 9601 et seq.] and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *Code of Federal Regulations* (CFR) 300]. The Federal Facility Agreement (FFA) [DOE 1992a] was developed to provide a legal framework for remediation activities at the ORR and to coordinate remedial activities under CERCLA and the Resource Conservation and Recovery Act of 1976 (RCRA). The FFA's integrated approach extends to preparation of decision documents under CERCLA and RCRA. In addition, National Environmental Policy Act of 1969 (NEPA) values are incorporated in the documents prepared for this project in accordance with the *Secretarial Policy Statement on the National Environmental Policy Act of 1969* (DOE 1994). This policy states that DOE will rely on the CERCLA process for review of actions taken under CERCLA and will address and incorporate NEPA values, to the extent practicable, in CERCLA evaluations.

A primary objective of the remediation measures presented in this ROD is to protect industrial workers from exposure to hazardous substances in Zone 2. The institutional controls restricting property use to industrial use, and the limited potential for off-site migration of contaminants, limit the potential for exposure to other individuals. As such, the focus of efforts under this ROD is aimed at eliminating or reducing existing contamination to levels below risk-based levels for workers on-site. This is done through the remediation of areas of contamination and the application of LUCs, including institutional controls, throughout the Zone 2 area to prevent an unacceptable risk of human exposure to contaminated soil and restrict the development of residential housing, schools, or daycare facilities. Another objective of the remediation measures in this ROD is to protect groundwater by removing contamination in soil, burial grounds, or infrastructure that could contribute to future groundwater contamination above maximum contaminant levels (MCLs).

DOE has developed a Land Use Control Assurance Plan (LUCAP) for the ORR to help ensure that land use restrictions are maintained and periodically verified. DOE will develop a Land Use Control Implementation Plan (LUCIP), which is an enforceable component of the remedial design, that will further detail the specific measures required for land use restrictions as part of this action. The LUCIP will be updated, as needed, with additional specific measures as individual response actions are completed. DOE is committed to implementing and maintaining LUCs, including institutional controls, to ensure that the selected remedy remains protective of human health. The implementation and funding of these activities will take place in accordance with the ORR FFA. The public will be informed and involved in the development and implementation of these requirements as mandated by CERCLA, the NCP, the ORR FFA, and the ORR CERCLA public involvement plan. Documents pertaining to the implementation and performance of the remedial actions, including an annual Remediation Effectiveness Report (RER) [as long as required by the FFA] and five-year reviews, will be placed in a post-ROD file, which will be available to the public.

This decision is supported by scientific studies and other pre-decisional investigation documents contained in the Administrative Record file for Zone 2 of ETTP. Normally, a final remedial investigation (RI) has been performed prior to completing a ROD. However, in this case, only a draft RI (DOE/OR/01-1778/V1-V5& D1) has been completed. Based on the information contained in the draft RI, contaminated areas warranting remediation were identified and a focused feasibility study (FFS) was developed and approved. The FFS was amended during final stages of development to add another alternative that was eventually selected as the remedy for Zone 2. Those areas with limited information will require additional sampling during implementation of the remedy. DOE has considered all comments received on the proposed plan in preparing this ROD. DOE, the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) [parties to the FFA] concur with the selected remedy.

1.3 ASSESSMENT OF THE SITE

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment. The potential for an unacceptable risk to an industrial worker exists in Zone 2 from soils, buried waste, and subsurface structures, including slabs. Contamination in soil and subsurface structures potentially presents a future threat to groundwater.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for ETTP Zone 2 is Alternative 5 from the FFS Addendum (DOE 2004b). This remedy addresses contaminated soil, buried waste, and subsurface structures throughout Zone 2, including the K-1070-C/D Classified Burial Ground. This decision also establishes remediation levels based on the reasonably anticipated future land use for Zone 2, industrial use, and on protecting the groundwater from future migration of contaminants in Zone 2 soil or buried waste. Industrial uses in general will be allowed to a maximum depth of 10 feet below ground surface (bgs). Use of the subsurface below 10 feet bgs will typically be restricted. It is DOE's intent to limit restrictions for Zone 2. Using the data from the industrial use scenario, DOE will evaluate all of Zone 2 for unrestricted use. In areas in which the information indicates there is little chance for unacceptable contamination, restrictions will not be imposed. In addition, the ROD and LUCIP allow excavations deeper than 10 feet with appropriate controls. The remedial action objective (RAO) for Zone 2 includes the following:

- protect human health under an industrial land use to an excess cancer risk at or below 1×10^{-4} and non-cancer risk levels at or below a hazard index (HI) of 1, and

- protect groundwater to levels at or below MCLs.

Following are the major components of the selected remedy:

- Assess data sufficiency for each exposure unit (EU), and supplement data as necessary to determine if remediation levels are exceeded.

- Remove soil up to 10 feet in depth that exceeds remediation levels set to protect a future industrial worker [recommended as unrestricted industrial worker by the Site-Specific Advisory Board (SSAB) End-Use Working Group]. Dispose of the soil at the Environmental Management Waste Management Facility (EMWMF), Y-12 Landfills, or other appropriate disposal facility deemed acceptable under the Off-site Rule.

- Remove soil to the water table, bedrock, or acceptable levels of contamination, whichever is the shallowest, to protect underlying groundwater to MCLs and to protect human health and the environment. Dispose of the soil at the EMWMF or other appropriate disposal facility deemed acceptable under the Off-site Rule.

- Remove or decontaminate the contaminated portions of slabs, vaults, basements, pits, tanks, pipelines, or any other subsurface structure that exceed the remediation levels to protect a future industrial worker to a depth no more than 10 feet. Guidelines for sampling, use of surficial contamination information, and use of the current soil volumetric remediation levels will be developed in the post-ROD primary documents. Use soil or concrete debris that meets Zone 2 remediation levels as backfill material in basements and deep excavations. Dispose of any material that does not meet the Zone 2 remediation levels at the EMWMF or other appropriate disposal facility deemed acceptable under the Off-site Rule.

- Remove the debris in the K-1070-B Old Classified Burial Ground, regardless of depth (to minimize potential future impact to surface water and to lessen long-term security needs), and soil that exceed remediation levels for the protection of workers (top 10 feet) or protection of groundwater (water table or bedrock surface). Dispose at the EMWMF, Y-12 Landfills, or other appropriate disposal facility deemed acceptable under the Off-site Rule.

- Remove the debris and soil in the K-1070-C/D Classified Burial Ground that exceed remediation levels for the protection of workers (top 10 feet) or protection of groundwater (water table or bedrock surface). Dispose at the EMWMF, Y-12 Landfills, or other appropriate disposal facility deemed acceptable under the Off-site Rule.

- Verify all acreage in Zone 2 as compliant with soil remediation levels established by the ROD.

- Implement LUCs to prevent exposure to residual solid contamination left on-site and/or to prevent residential use of the land.

LUCs are a necessary part of the selected remedy to ensure its protectiveness. The types and objectives of LUCs that will be developed and implemented under this remedy include (1) property record restrictions to restrict unauthorized uses of remediated and residually contaminated properties; (2) property record notices to provide notice to anyone searching records about the existence and location of contaminated areas and limitations on their use; (3) zoning notices to relevant local authorities about the existence and location of waste disposal sites and areas of residual contamination to facilitate local zoning/ planning efforts; and (4) an excavation/penetration permit program to provide notice to permit requestors of the existence of contaminated areas and to prohibit, or otherwise limit, excavation/penetration activities not consistent with applicable LUCs. Other LUCs, such as fences and signs, will be used to restrict access in the short-term until remediation is complete, and fences and surveillance patrols will be applied to the K-1070-C/D Classified Burial Ground until there are no remaining security issues. The need for LUCs for the protection from contaminated groundwater, surface water, or sediment will be determined in the future Site-wide ROD. The LUCs selected in this Zone 2 ROD will be implemented as an integral part of the selected remedy. DOE will be responsible for implementing, monitoring, maintaining, reporting on, and enforcing the LUCs selected in this ROD consistent with the requirements of the LUCIP approved for HTTP Zone 2. The Zone 2 LUCIP will be submitted as a component of the enforceable post-ROD primary FFA documents addressing the remedial design report and the remedial action work plan (RDR/RAWP). Upon regulatory approval, the Zone 2 LUCIP will establish LUC implementation and maintenance requirements enforceable under CERCLA and the FFA.

Although DOE may later transfer the procedural responsibilities for LUC implementation to another party by contract, property transfer agreement, property lease agreement, or through other means, DOE retains ultimate responsibility for the integrity and protectiveness of the remedy. Concurrent with the transfer of any fee title from DOE to a transferee, information regarding the environmental use restrictions and controls will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property'. In the event DOE determines to enter into any contract for the lease, sale, or transfer of any of the site, DOE will comply with the requirements of Section 120(h) of CERCLA and the ORR FFA (specifically, Section XLIII) regarding property transfer in effectuating that sale or transfer, including all notice requirements and provisions for the continued maintenance of LUCs that are no less restrictive than those described in this ROD. Any lease agreement or property transfer deed will contain appropriate provisions to ensure that these restrictions continue to run with the land and are enforceable by DOE, or successor agency. Each transfer of fee title will include, as applicable, a CERCLA 120(h)(3) covenant that will have a description of the residual contamination on the property and the land use restrictions, and include deed provisions expressly forbidding activities inconsistent with the performance measure goals and objectives. Each transfer deed will also contain a reservation of access to the property for DOE, EPA, and the state of Tennessee for purposes consistent with the FFA.

The NCP establishes an expectation that treatment will be used to address the "principal threat wastes" at a site wherever practicable [40 CFR 300.430(a)(l)(iii)(A)]. Principal threat wastes are those contaminated materials considered highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. There is no principal threat waste to be addressed as part of this action. The principal threat wastes associated with Zone 2 are dense, nonaqueous-phase liquids (DNAPLs) in the subsurface, which are not addressed under this ROD. They will be addressed under the following Site-wide ROD.

The decision in this Zone 2 ROD is similar to the decision in the Zone 1 ROD. Both decisions address soil, buried waste, subsurface structures, and scrap that could cause a future threat to an industrial worker. There have been several earlier source control decisions in both zones (e.g., K-1070-A burial ground) that have removed many of the sources of future risk to an industrial worker. These early actions are consistent with the Zones 1 and 2 RODs. Following these decisions, a final Site-wide ROD will be developed, which provides a decision on actions necessary on the groundwater, surface water, and sediment of ETTP. In addition, this final ROD will address any residual contamination in the soil that could pose a future threat to terrestrial species.

1.5 STATUTORY DETERMINATIONS

Alternative 5 was selected because scientific investigations and other pre-decisional studies have provided sufficient evidence for DOE, EPA, and TDEC to conclude that the remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements (ARARs), is cost-effective, and uses permanent solutions to the maximum extent practicable. The excavation of contaminated soil and other contaminated material associated with this remedy, which includes disposal of contaminated soil and debris at the EMWMF, Y-12 Landfills, or other appropriate facility and use of concrete and other earthen material as fill at the ETTP, will protect human health and the environment because the risk from contaminated material is eliminated or significantly reduced. No ARAR waivers are necessary. Alternatives with containment or treatment technologies as the primary action were not developed for the following reasons:

- Removal is less costly than containment due to lower capital costs and lower operation and maintenance (O&M) costs and is more effective in the long-term than the long-term maintenance of caps.

- Containment of contaminated material above the established remediation levels is inconsistent with the end use of the facility because it still poses an unacceptable risk to industrial workers.

- Treatment technologies are either not available or not cost-effective for reducing the toxicity, mobility, or volume of radionuclides, which constitute the primary contaminants of concern (COCs) for Zone 2.

- Treatment to reduce mobility (stabilization) does not meet the end use objective unless the material is moved to the EMWMF after treatment. The combination of treatment and disposal at the EMWMF, when not required to meet the waste acceptance criteria (WAC), is not cost-effective.

- Treatment to reduce volume (soil washing, etc.) has limited effectiveness in the clay soils present at ETTP.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. DOE will include this five-year review as part of the ORR-wide RER, a primary document submitted for EPA and TDEC approval in accordance with requirements of the FFA for the ORR.

Because hazardous substances above health-based levels might remain in Zone 2 after implementation of this remedy, DOE, TDEC, and EPA recognize that Natural Resource Damage claims, in accordance with CERCLA, could be applicable. This document does not address restoration or rehabilitation of all natural resource injuries that may have occurred or the question of whether such injuries have occurred. Neither DOE nor TDEC waives any rights or defenses it might have under CERCLA, Section 107(a) 4(c).

1.6 ROD CERTIFICATION CHECKLIST

The following information is included in Part 2, "Decision Summary," of this ROD:

- COCs and their respective concentrations (Section 2.7),
- baseline risks represented by the COCs (Section 2.7),
- remediation levels established for the COCs and the basis for the levels (Section 2.12.6),
- current and future land use assumptions used in the baseline risk assessment and ROD (Section 2.6.2),
- decisive factor(s) that led to selection of the remedy (Section 2.12.1),
- land use that will be available at the site as a result of the selected remedy (Section 2.12.1),
- ways in which source materials constituting principal threats are addressed (Section 2.11), and
- an evaluation of costs of the selected remedy (Section 2.12.5).

Additional information regarding Zone 2 of ETTP can be found in the Administrative Record for this site.

APPROVALS

Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee DOE/OR/01-2161&D2 March 2005

Gerald Boyd, Manager
Oak Ridge Operations
U. S. Department of Energy

4/14/05
Date

John A. Owsley, Director
U. S. Department of Energy Oversight Division
Tennessee Department of Environment and Conservation

4/15/05
Date

Winston A. Smith, Director
Waste Management Division
U. S. Environmental Protection Agency, Region 4

4-19-05
Date

PART 2. DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

Zone 2 at East Tennessee Technology Park
Oak Ridge Reservation
Oak Ridge, Tennessee
CERCLA Information System ID #TN1890090003

The 34,516-acre DOE ORR is located within and adjacent to the corporate limits of the city of Oak Ridge, Tennessee, in Roane and Anderson counties. The ORR is bounded to the east, south, and west by the Clinch River and on the north by the developed portion of the city of Oak Ridge. The ORR hosts three major industrial research and production facilities originally constructed as part of the World War II-era Manhattan Project: ETTP, formerly the K-25 Site and ORGDP; Oak Ridge National Laboratory (ORNL), formerly X-10; and the Y-12 National Security Complex (hereafter Y-12 Complex) [Fig. 2.1].

ETTP is located near the northwest corner of the ORR with more than 5000 acres considered part of ETTP. Potentially impacted areas account for roughly 2200 acres of the 5000 acres. A decision was made by the FFA parties to divide the site into two smaller areas (called zones) for decision-making. The potentially impacted area of ETTP currently is divided into two zones: outside the main fence (Zone 1 – 1400 acres) and inside the main fence (Zone 2 – 800 acres) [Fig. 2.2]. Historically Zone 1 was used for light industrial purposes and has some open areas with waste disposal. Zone 2 is the main plant area and has historically had a heavy industrial use.

Zone 2 has been divided into seven geographic areas to simplify discussion of the site conditions (Fig. 2.3). The description of each area follows.

The **Mitchell Branch Area** encompasses 110 acres in the northeast comer of ETTP and includes facilities surrounding that part of Mitchell Branch and its tributaries. The K-1070-B Old Classified Burial Ground, a 3.7-acre area, is part of the Mitchell Branch Area. The burial ground was created by filling in the topographic low. The K-1420 Facility served as the decontamination and uranium recovery facility for ETTP and is also located in this area. There is extensive soil and groundwater contamination in this area.

The **K-1401/K-1070-C/D Area** encompasses 96 acres on the eastern portion of ETTP. The largest burial ground, K-1070-C/D, is located in this area. This 22-acre piece of land includes trenches used for solid waste disposal and pits used for liquid waste disposal. A large plume of volatile organic compound (VOC) contamination emanates from one of the pit areas. Also included in this area is a large ex-maintenance facility, K-1401, that had a leaking acid pipeline that historically caused groundwater contamination.

The **Administrative/Laboratories Area** contains numerous administrative buildings and laboratories in a 73-acre area. Included in this area is the K-1004-J complex that served as laboratories historically. Smaller amounts of soil contamination exist, and a VOC groundwater plume crosses this area.

The **K-1064 Peninsula Area** is an 18-acre area at the north end of ETTP. A number of activities have occurred in this area over time, including drum storage, burning, drum deheading, and currently scrap storage. A trash area exists along the banks of Poplar Creek. The levels of contamination in this area are notably lower than in the earlier mentioned areas.

The **K-25 Area** is 148 acres in the center of the plant taken up almost exclusively by the K-25 building. This area is heavily industrialized and does contain smaller support buildings, including the K-1413 Laboratory. There are isolated areas of soil contamination but little suspected groundwater contamination.

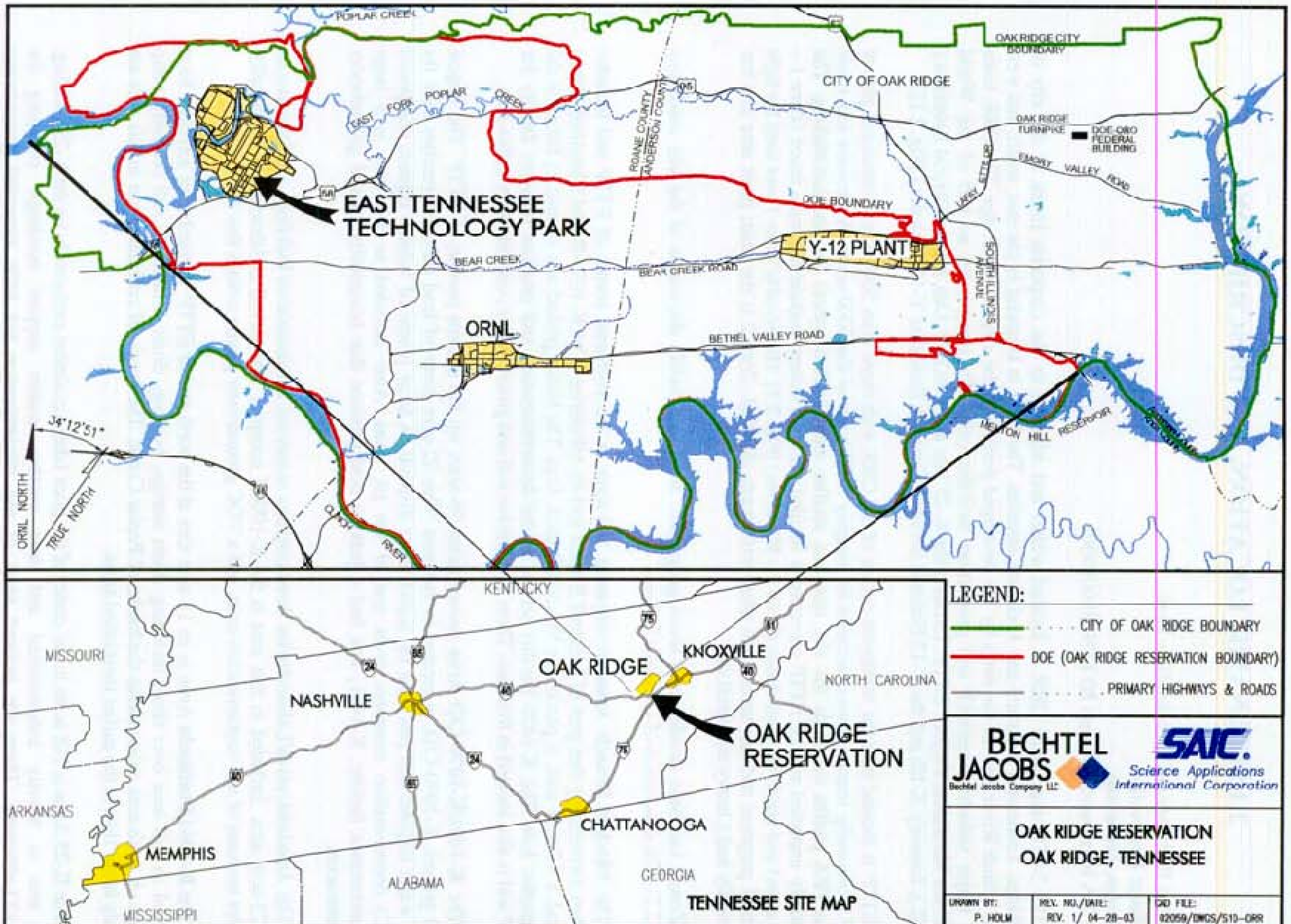

Fig. 2.1. Location of Oak Ridge Reservation and East Tennessee Technology Park.

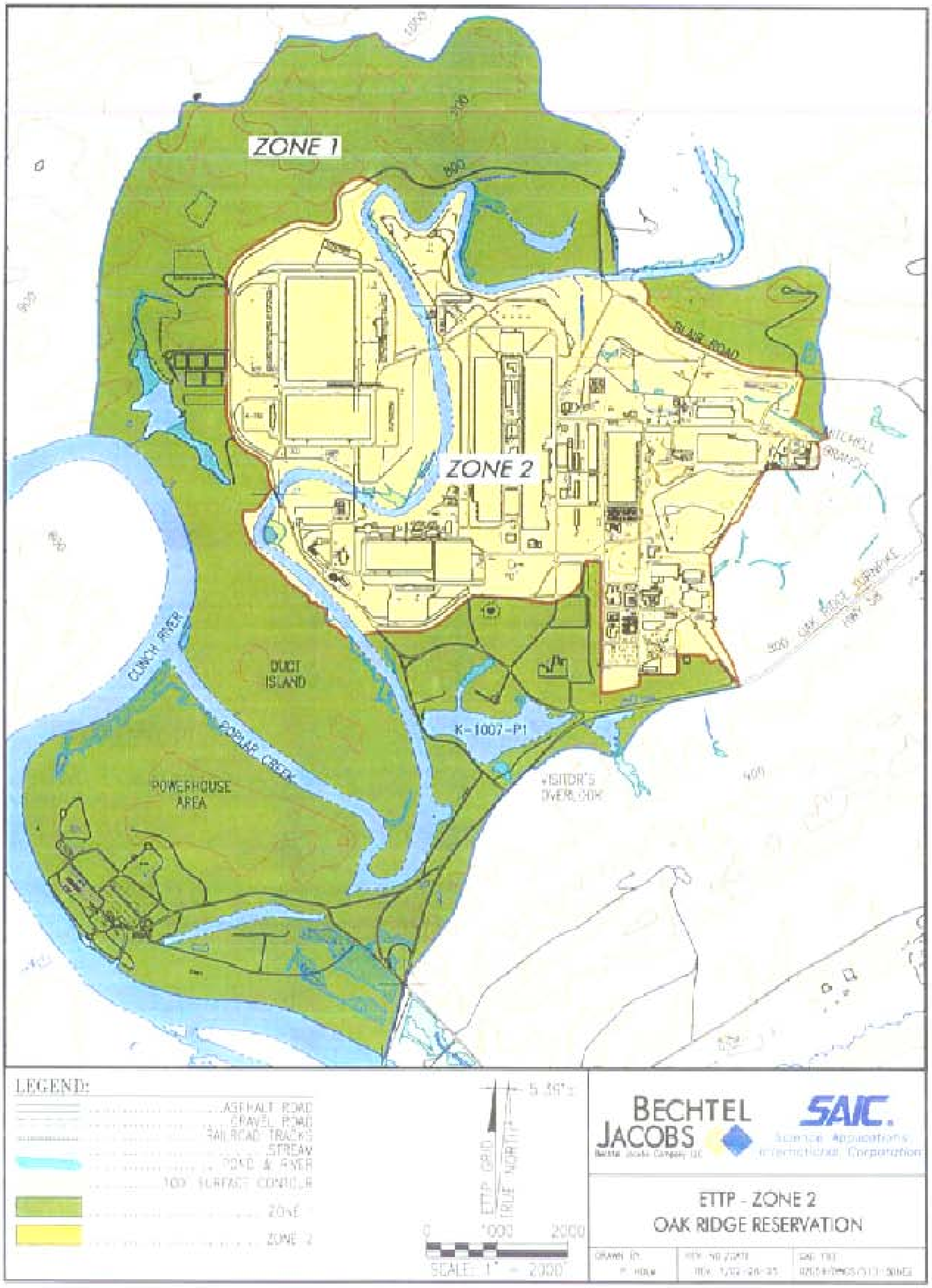

Fig. 2.2. ETTP Zone 2 location map.

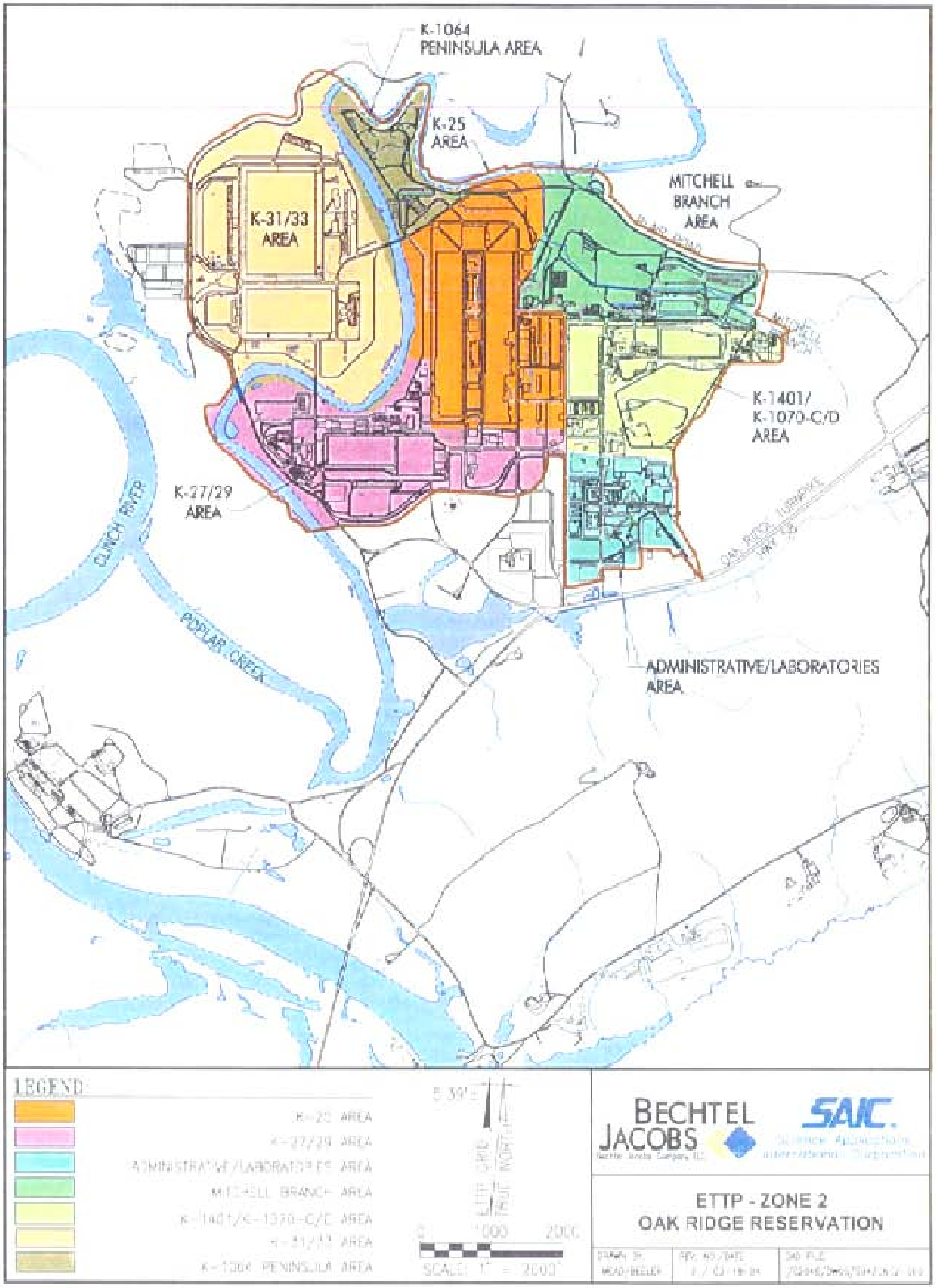

Fig. 2.3. ETTP Zone 2 geographical areas.

The **K-27/29 Area** encompasses 122 acres in the southern part of the main plant area at HTTP and is bounded to the west by Poplar Creek. The K-1410 Plating facility and two large process buildings (K-27 and K-29) are located here. Miscellaneous soil and groundwater contamination has resulted from activities associated with the various buildings located in this area.

The **K-31/K-33 Area** is 170 acres in the northwest portion of HTTP. The large K-31 and K-33 process buildings are located here, but current data show environmental contamination is below risk concerns.

In accordance with CERCLA Section 120 and 40 CFR 300.430(f)(4) and the FFA, DOE is acting as the lead agency for this action. TDEC and EPA, as parties to the FFA, provide oversight and approval of the remedy selection and implementation.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

ETTP was built by the U.S. Army Corps of Engineers, as part of the Manhattan Project, beginning in 1942. From 1942 to 1964, the gaseous diffusion technology was used to enrich uranium for use in nuclear weapons. The facility was called the ORGDP and had five primary process buildings (K-25, K-27, K-29, K-31, and K-33) where enriched uranium was produced. In 1964, military production of highly enriched uranium was discontinued, and the K-25 and K-27 process buildings were shut down.

For the next 20 years, the primary mission of ORGDP was the production of low-enriched uranium for fabrication into fuel elements for commercial and research nuclear reactors. Secondary missions in the mid-1980s included research on new technologies for uranium enrichment such as gas centrifuge and laser isotope separation. In 1985, because of a decline in the demand for enriched uranium, DOE placed the ORGDP in standby mode. The decision to permanently shut down the facility was made in 1987. These activities, as well as activities at the Y-12 Complex and ORNL, have resulted in the release of contaminants to the environment. Because of these contaminant releases, the ORR was placed on the EPA National Priorities List (NPL) established under CERCLA (54 *Federal Register* 48184, November 21,1989).

As a result of the NPL listing, the EPA, TDEC, and DOE signed an FFA for the ORR (DOE 1992), effective January 1, 1992. The general purposes of the FFA include ensuring that the environmental impacts associated with past and present activities on the ORR are thoroughly investigated; ensuring that appropriate remedial action is taken to protect the public health and welfare and the environment; and establishing a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions on the ORR in accordance with CERCLA, the NCP, RCRA, NEPA, appropriate guidance and policy, and in accordance with Tennessee state law.

ETTP historical missions have produced a diverse legacy of the following contaminated inactive facilities, waste disposal areas, and secondarily contaminated media that are potential candidates for remediation:

- buildings and other facilities,
- buried waste (burial grounds and landfills),
- buried tanks,
- underground waste lines,
- scrap and debris,
- contaminated surface and subsurface soil,
- contaminated surface water and sediment, and
- contaminated groundwater.

Historical information identified several areas of contamination in Zone 2. These sites have been listed in the FFA and are listed in Appendix A of this ROD.

2.2.1 PREVIOUS INVESTIGATIONS AND DATA SOURCES

A comprehensive field investigation of the entire ETTP site was conducted in 1997 through 1998. This investigation resulted in a draft sitewide RI report in 1999 (DOE 1999a). This report summarized historical information as well as the results of the 1997-1998 field investigation. Key historical sampling events in Zone 2 included a sitewide radiological walkover in 1994 and 1995 (also included surface soil sampling for radionuclides) and sampling for groundwater, surface soil, subsurface soil, surface water, and sediment as part of the earlier sitewide RI effort. A complete and approved remedial investigation/ feasibility study (RI/FS) is available for the K-1070-C/D Classified Burial Ground. It was published in 1995 and resulted in an early removal action of the G-Pit. Other sampling summarized in the RI report included that associated with other early groundwater actions.

2.2.2 PREVIOUS CLEANUP DECISIONS

Previous cleanup decisions under CERCLA and other authorities have addressed, or are now addressing, some of the contamination in Zone 2, as follows:

- K-1407-B/C ponds RCRA closure and CERCLA no further action (ROD in 1993) [DOE 1993];
- SW-31 spring collection (ROD in 1992) [DOE 1992b];
- K-1420/K-1401 sump collection [Action Memorandum (AM) in 1997] (DOE 1997a);
- K-1417-A&B storage yard remediation (ROD in 1991) [DOE 1991];
- Mitchell Branch and K-1070-C/D plume collection (AM in 1997) [DOE 1997b[;
- K-25 Auxiliary Facility Demolition Group 1 Building Demolition (AM in 1997) [DOE 1997c];
- K-25 Auxiliary Facility Demolition Main Plant Buildings (AM in 2000) [DOE 2000a];
- Three-Building Decontamination and Decommissioning (D&D) and Recycle (AM in 1997) [DOE 1997d];
- K-1421 and K-1422 Demolition (under NEPA);
- G-Pit removal and concrete pad cover (ROD in 2000) [DOE 2000b];
- K-25 and K-27 Buildings D&D (AM in 2002) [DOE 2002a]; and
- Group 2, Phase II Building Demolition (AM in 2002) [DOE 2002b].

These actions have been used to control contaminated groundwater migration, to remove settling ponds and to demolish various buildings across Zone 2. The source removal actions listed above are consistent with the remedy selected in this ROD. Potential sources of groundwater contamination (e.g., G-Pit) or contamination with unacceptable future risk to humans (K-1407-B/C Ponds) were removed. Had they not been removed as early actions, they would have been identified for action under this ROD.

Building removal is a precursor to soil remediation. The building demolitions provide access to contaminated soil. The groundwater contaminant migration control actions have been used in the interim, until the final Site-wide decision for residual contamination is made and/or until the various early source actions begin to have some impact on the groundwater quality.

2.2.3 LAND USE CONTROLS

DOE will develop a LUCIP as a component of an enforceable post-ROD primary document or as a stand-alone primary document for regulator approval within 90 days of the ROD signature. The LUCIP shall contain LUC implementation and maintenance actions, including the requirement for periodic inspections. Upon regulatory approval, the Zone 2 LUCIP will establish the LUC implementation and maintenance requirements enforceable under CERCLA and the FFA. It is anticipated that the LUCIP will be modified following completion of the remedial action, and potentially reduce the areas subject to land use restrictions. DOE will not modify or terminate the LUCs or implementation actions, or modify land use without prior approval by EPA and the TDEC. The DOE will obtain prior concurrence from EPA and TDEC before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

Although DOE may later transfer the procedural responsibilities for LUC implementation to another party by contract, property transfer agreement, property lease agreement, or through other means for certain Zone 2 properties, DOE retains ultimate responsibility for the integrity and protectiveness of the remedy and the enforcement of LUCs. Concurrent with the transfer of any fee title from DOE to a transferee, information regarding the environmental use restrictions and controls will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property. In the event DOE determines to enter into any contract for the lease, sale, or transfer of any of the site, DOE will comply with the requirements of Section 120(h) of CERCLA and the ORR FFA (specifically, Section XLIII) regarding property transfer in effectuating that sale or transfer, including all notice requirements and provisions for the continued maintenance of LUCs that are no less restrictive than those selected in this ROD as part of the Zone 2 remedial action. Any lease agreement or property transfer deed will contain appropriate provisions to ensure that these restrictions continue to run with the land and are enforceable by DOE. Each transfer of fee title will include a CERCLA 120(h)(3) covenant that will have a description of the residual contamination on the property and the environmental use restrictions, expressly forbidding activities inconsistent with the performance measure goals and objectives. Each transfer deed will also contain a reservation of access to the property for DOE, EPA, and the state of Tennessee for purposes consistent with the FFA.

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

DOE published a public notice of availability for the *Proposed Plan for Contaminated Soil, Buried Waste, and Subsurface Structures in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, in *The Oak Ridger*, the *Knoxville News-Sentinel*, the *Roane County News*, the *Clinton Courier News*, and other local newspapers within the region. The public notice established a public comment period from July 26, 2004, to September 8, 2004, but was extended twice at the public's request to October 18, 2004. A public meeting was held on August 24, 2004, to present the preferred alternative described in the proposed plan (DOE2004c) and solicit public input. All comments on the proposed plan are identified, and responses are included in Part 3, "Responsiveness Summary," of this ROD.

DOE has invited public participation in the Zone 2 project through periodic briefings with the Oak Ridge Site Specific Advisory Board (ORSSAB), a community-based advisory organization established to provide recommendations to DOE on remediation decisions on the ORR. The goals and selected remedy presented in this ROD are consistent with recommendations made by the ORR End Use Working Group (EUWG), a subcommittee of ORSSAB. The EUWG was established in 1996 to provide recommendations to DOE on post-remediation ORR land use, cleanup assumptions and goals, and beneficial reuse of portions of the ORR. The EUWG recommended unrestricted industrial (remediation to 10 feet) for most of Zone 2, with a portion covering much of the K-1070-C/D Classified Burial Ground area being controlled industrial (remediation to 2 feet) [Fig. 2.4].

This ROD presents the selected remedy for Zone 2. This remedy was chosen in accordance with CERCLA, as amended by SARA, and, to the extent practicable, the NCP. This decision is based on the scientific investigations and other pre-decisional supporting studies contained in the Administrative Record for this project. Listed below are the principal documents supporting this ROD:

- *Phase 2 Remedial Investigation/Baseline Risk Assessment Report and Feasibility Study for the K-1070-C/D Classified Burial Ground at the Oak Ridge K-25 Site, Oak Ridge, Tennessee* (DOE 1995);

- (draft) *Remedial Investigation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 1999a);

- *Focused Feasibility Study for Zone 2 Soils and Buried Waste, East Tennessee Technology Park, Oak Ridge, Tennessee*, and its addendum (DOE 2004a, DOE 2004b); and

- *Proposed Plan for Contaminated Soil, Buried Waste, and Subsurface Structures in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2004c).

These documents and other information supporting the selected remedy can be found at the DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee, 37830; (865) 241-4780.

2.4 SCOPE AND ROLE OF THE ACTION

The scope of the remedial actions in this decision is focused on the 800-acre area designated as Zone 2 in ETTP (Fig. 2.2). This area is primarily industrialized with many facilities remaining. As a result of the historic production-related activities in Zone 2, surrounding media have been contaminated. This action focuses on sources of releases and on areas of soil contamination.

The selected remedy includes contamination removal and imposition of LUCs as the overall cleanup strategy for Zone 2. Contaminant sources and contaminated soil will be removed, and LUCs will be imposed over the entire Zone 2 area, including deep soils below the surface of Zone 2, in order to protect human health.

Since the scope of the selected remedy includes areas that lack sufficient data to confirm whether unacceptable levels of contamination exist, DOE will develop, for approval under the FFA for the ORR (DOE 1992a), a sampling plan for filling data gaps remaining in Zone 2. It is anticipated that the sampling strategy will generally follow the sampling strategy developed for Zone 1.

Existing data, combined with newly analyzed data collected for this action, will be used to determine the levels and extent of residual contamination, if any, in site soils, and the verification strategy will describe how to compare contaminant conditions with the Zone 2 soil remediation levels presented in this ROD. The verification strategy which is based in part on the guidance found in the *Multi-Agency Radiation*

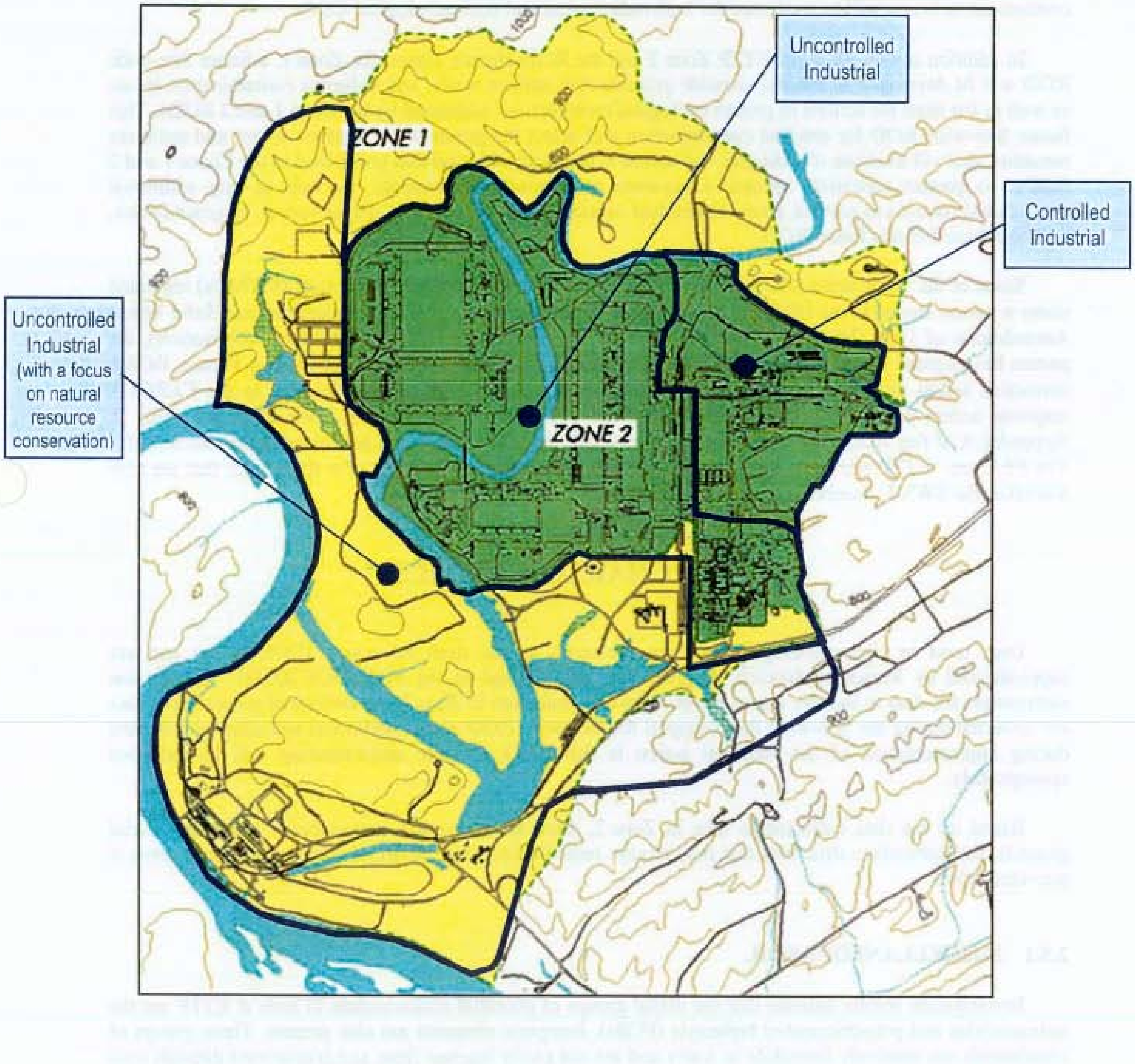

Fig. 2.4. End Use Working Group land use recommendation compared to current Zone 1 and Zone 2 designations.

Survey and Site Investigation Manual (MARSSIM) [DOE et al. 2000c] and the data quality objective (DQO) process (EPA 1994), will be used to demonstrate compliance with Zone 2 soil remediation levels. Soil contamination levels will be evaluated for both radiological and non-radiological COCs.

In addition to this ROD for ETTP Zone 2 and the ROD already signed for Zone 1, a future Site-wide ROD will be developed to address sitewide groundwater, surface water, and sediment contamination issues as well as the need for actions to protect ecological receptors not addressed by the Zone 1 and 2 RODs. This future Site-wide ROD for residual contamination will select the groundwater, surface water, and sediment remedies and will evaluate if additional soil action is necessary, beyond that prescribed in the Zones 1 and 2 RODs, to protect terrestrial species. Long-term monitoring requirements, as well as any additional institutional controls to prevent access to residual contamination in surface water, sediment, or groundwater, will be selected in this future ROD.

Some of the waste areas addressed in this ROD are solid waste management units (SWMUs) regulated under a permit issued to the ORR (0TN 001) under the authority of the RCRA Hazardous and Solid Waste Amendments of 1984 (HSWA). In accordance with FFA Section IV (RCRA/CERCLA Coordination), the parties have agreed that for the inactive SWMUs listed in Appendix A-1 (a) of the HSWA Permit, RCRA corrective action that would otherwise be required under that permit will be deferred to the CERCLA response action process as implemented under the FFA. FFA-listed sites in Zone 2 are presented in Appendix A of this ROD, along with the ways in which those sites are being addressed under this remedy. The FFA site “ETTP site-wide soils” is also partially addressed in this ROD. For those sites that are also SWMUs, the SWMU number is included in the table.

2.5 SITE CHARACTERISTICS

Data used in characterizing Zone 2 are presented in the draft RI report (DOE 1999a) and are supplemented by Reindustrialization Program data summarized in the FFS (DOE 2004a). This section summarizes the data to broadly depict the primary contamination in Zone 2. As additional groundwater data are collected during the Site-wide RI to support the Site-wide ROD and as additional soil data are collected during implementation of the remedial action in this ROD, the site understanding will be modified appropriately.

Based on the data collected to date in Zone 2, there are numerous contaminated soil areas, burial grounds, and subsurface structures that may require remediation. More detail on some of the larger areas is provided below.

2.5.1 MISCELLANEOUS SOIL

Investigation results indicate that the major groups of potential contaminants in soils at ETIP are the radionuclides and polychlorinated biphenyls (PCBs). Inorganic elements are also present. These groups of constituents are relatively immobile in water and are not easily leached from and transported through soils (DOE 1999a). Some residual VOC contamination remains, but due to greater mobility, much of the VOC contamination has already leached through the soil. Figure 2.5 presents a conceptual site model (CSM) for soil contamination, including how the major contamination may be migrating.

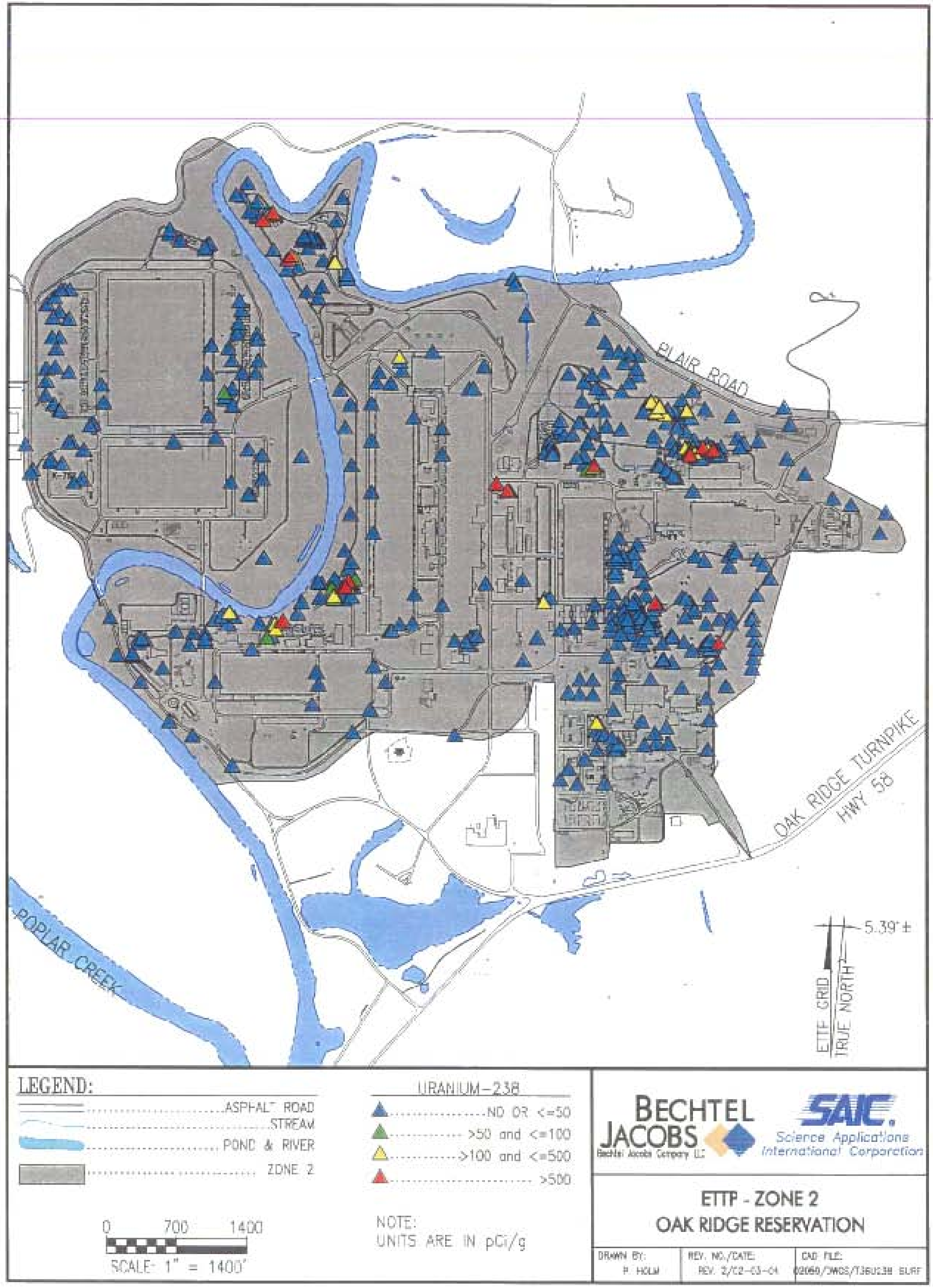

Fig. 2.6. U-238 distribution in surface soil (0 to 2 ft) in Zone 2 at ETTP.

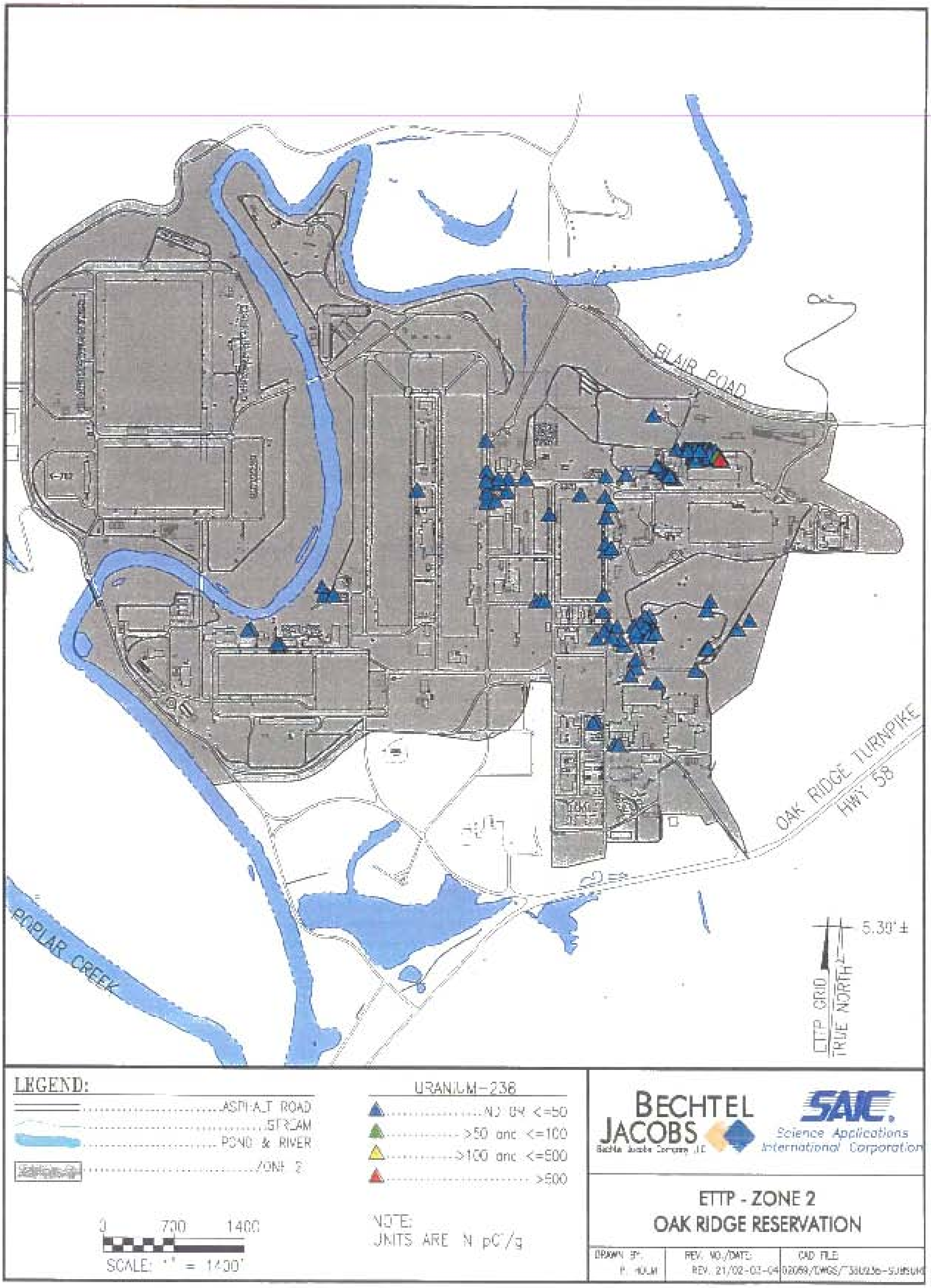

Fig. 2.7. U-238 distribution in subsurface soil (2 to 10 ft) in Zone 2 at ETTP.

2.5.2 K-1070-8 OLD C:LASSIFlED BURIAL GROUND

The K-1070-B Old Classified Burial Ground is located in thc northeast part of thc rnain plant area in the Mitchell Branch area as shown in Figure 2 8 A site-specific CSM for the K-1070-B Old Classified Burial Ground is presented in Figure 2.9. At its closest point, the site is approximately 150 feet southwest of the nearest surface water body, Mitchell Branch, a tributary of Poplar Creek. The K-1066-B Cylinder Yard and former K-1045-A Fire Training Facility are located on the burial ground. Storm drain (SD)-190, process lines, and a water line run through the burial ground. The surface of the burial ground slopes steeply downward to the north and east

The burial ground was a waste disposal site between the early 1950s and 1976. A wide variety of wastes were disposed at the burial ground, including material removed from the White Wing Scrapyard in the mid-l960s. Asbestos and metals, including lead, uranium, aluminum, copper, beryllium, bronze, and brass were also buried at the site. No operations or activities are currently being conducted at the burial ground other than routine maintenance. Possible contaminants in waste at the site include PCBs, metals, uranium, uranium fluorides, oxyfluorides, and tetrafluorides. Disposal of liquid organic contaminants and hydrocarbon oils at the site is thought to have been minimal [Lockheed Martin Energy Systems. Inc (LMES) 1993]. Wastes buried in the subsurfacc are most likely (probable condition) not leaching to the groundwater at levels of concern. However, there is a possibility (reasonable deviation) that the waste could be a future source of groundwater contamination.

There are radiological data for several surface soil samples from the K-1070-B Old Classified Burial Ground and chemical data for a few samples collected in the vicinity of a former fire training facility. These data are representative of clean borrow soil brought to the site to cover the waste. Contaminants identified in surface soil include ^{137}Cs, ^{237}Np, ^{234}U, ^{235}U, and ^{238}U. These contaminants arc associated with two sample locations along the southern boundary of the burial ground. There are no subsurface soil samples at the K-1070-B Old Classified Burial Ground, however, historical records document the disposal of hazardous materials in the burial ground. Groundwater in this area flows north toward Mitchell Branch. Groundwater quality data from the K-1070-B Old Classified Burial Ground indicate the presence of VOCs. radionuclidcs, and inorganic elements and compounds. Groundwater in the vicinity of K-1070-B, which was monitored at eight wells, both upgradient and down gradient of the burial ground, showed concentrations greater than MCLs for nine metals, bis(2-ethylhexyl)phthalate, and eight VOCs. Metals exceeding MCLs in groundwater included antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, and selenium. Radionuclides were not detected at concentrations exceeding MCLs at any of the groundwater wells in the vicinity of the K-1070-B Old Classificd Burial Ground.

Four VOCs and nickel were detected in water samples collected from the SD-190 network under dry (minimal flow) conditions TCE, l,l-dichloroethane, 1-1-dichloroethene (DCE), and vinyl chloride were detected at the SD-190 outfall and/or in samples collected from within the drain system leading to the outfall. Nickel was detected from samples collected from the SD network. None of these constituents was detected in surface soil at concentrations above levels of concern. These results suggest that leachate or contaminated groundwater is infiltrating the SD-190 networks within the burial ground. While nickel is potentially originating from wastes buried in the K-1070-B Old Classificd Burial Ground, the VOCs are likely components of the VOC plumes originating upgradient of the burial ground and passing through it.

2.5.3 K-1420 FACILITY AREA

The K-1420 Facility Area is an approximately 2.1-acre tract comprised of Bldg. K-1420 Decontamination and Uranium Recovery Building, the K-1420 Oil Storage Facility, and the K-1420 Process Line Area located in the Mitchell Branch area (Fig. 2.8). The K-1420 Process Lines lie beneath the K-1420 Oil Storage Facility (LMES 1995). SD-160, a storm drain, crosses beneath the storage facility.

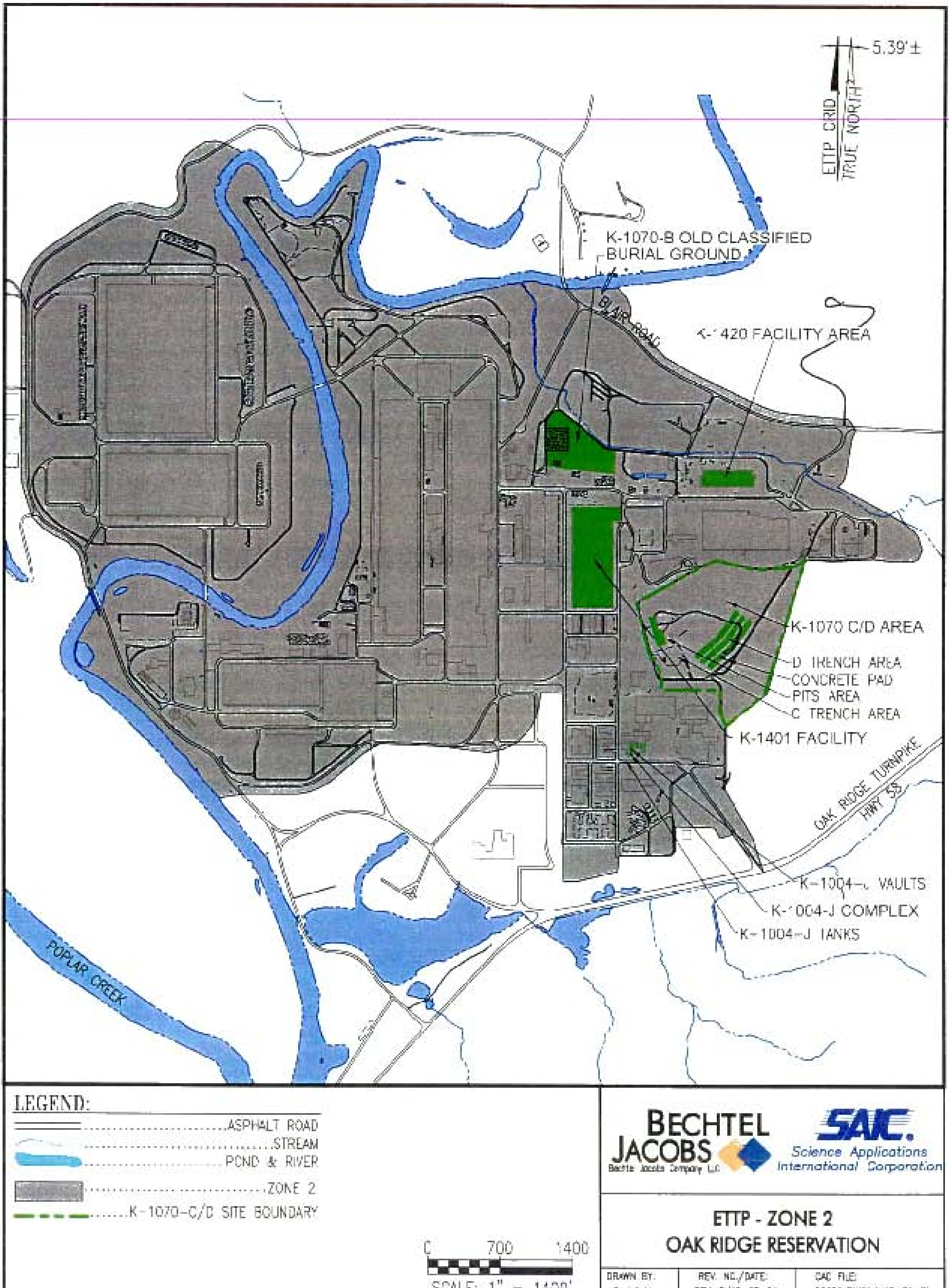

Fig. 2.8. Zone 2 at ETTP.

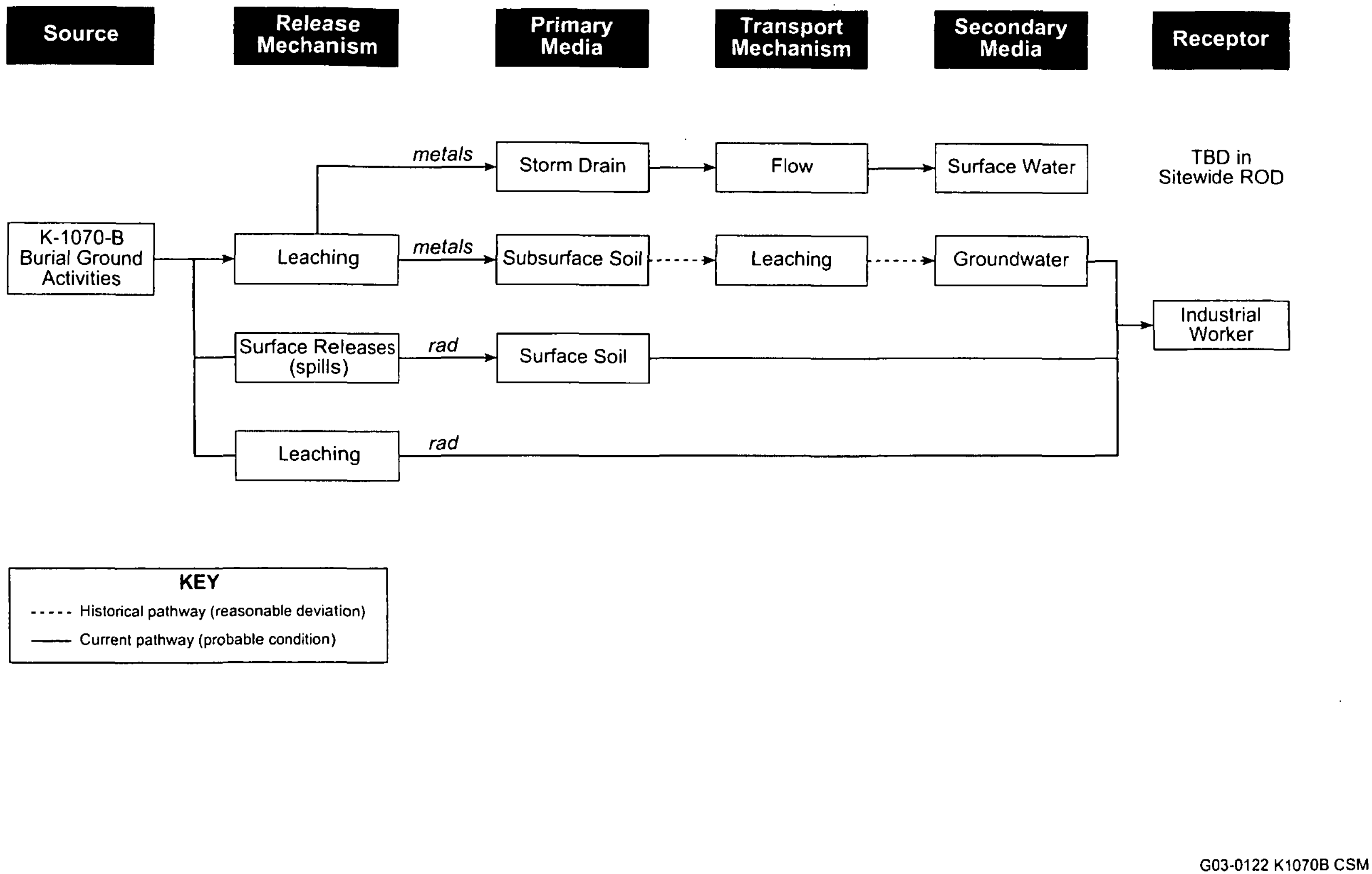

Fig. 2.9. K-1070-B Old Classified Burial Ground conceptual site model.

The K-1420 Oil Storage Facility began operation some time after the K-1420 Decontamination and Uranium Recovery Building was built in 1953. Drums of waste uranium-cascade motor lubricant oil were stored at the site. This oil reportedly contained PCBs and 2 to 3% uranium. There is evidence that oil leaked from the drums. Uranium solutions, stored in safe-geometry dollies, were also stored at the facility. Radiologically contaminated materials were stored at the site until 1994 [Martin Marietta Energy Systems, Inc. (MMES) 1995].

Although infiltration at the oil storage area is minimal due to the asphalt cover, mobile contaminants leached from subsurface soil at the K-1420 Oil Storage Facility move downward with water as it percolates to the water table. Once mobile contaminants reach the water table, they potentially move laterally with the groundwater toward Mitchell Branch and Poplar Creek. Deep soils (>12 feet bgs) are potentially contaminated by VOCs released from the subterranean facilities in K-1420 Facility Area (DOE 1999a).

Some of the highest concentrations of alpha activity, beta activity, ^{99}Tc, ^{228}Th, ^{232}Th, $^{233/234}$U, ^{235}U, and ^{238}U detected in groundwater at ETTP occur in the groundwater samples collected downgradient of the K-1420 Facility Area. Groundwater in the vicinity of the K-1420 Facility Area showed concentrations at least one time greater than MCLs for alpha activity, rune metals (arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, and thallium), bis(2-ethylhexyl) phthalate, and six VOCs. Three of the six groundwater VOCs above MCLs were detected in soil: methylene chloride, PCE, and TCE. Building K-1420 is known to have been a source of TCE to deep soil and groundwater beneath the K-1420 Oil Storage Facility.

There are chemical data from numerous surface and subsurface soil samples at the K-1420 Facility Area, as well as results from the 1994 and 1995 radiological walkover surveys. Contaminants in surface and subsurface soil at the K-1420 Oil Storage Facility include ^{137}Cs, ^{237}Np, ^{234}U, ^{235}U, and ^{237}U. Above-background concentrations of uranium are pervasive around Bldg. 1420. The most widespread radionuclide was ^{234}U, which was observed in over 40% of the sample data set. The distribution is representative of the other radionuclide contaminants detected. The majority of contamination is located to the northwest of the K-1420 Facility Area, between the K-1420 Decontamination and Uranium Recovery Building and Mitchell Branch, mostly within the surface soil horizon. Some subsurface soil contamination has occurred due to leaking process lines.

2.5.4 K-1070-C/D AREA

The K-1070-C/D Classified Burial Ground is a 22-acre tract of land within the ETTP main plant area (Fig. 2.8). Waste disposal at the K-1070-C/D Classified Burial Ground began in 1975 and was discontinued in 1989. The K-1070-C/D Classified Burial Ground contains multiple disposal sites, including the K-1070-D Trenches (Trenches A, B, and C); the K-1070-C Area (prior to use as a maintenance storage area); the K-1070-D Pits area (10 small liquid and solid waste disposal plots); and a concrete pad (DOE 1995). A CSM of the burial ground area is presented in Fig. 2.10.

Trench areas. The K-1070-C Area was used as a burial area beginning in 1975 and continuing to mid-1976. This area covers an area of 2.12 acres. The nature and quantity of wastes disposed are not known because disposal records were not maintained during this period. Based on interviews with employees who worked at the K-1070-C Area, it is likely that these wastes included hazardous and radiological constituents. Records indicate that a wide variety of waste was disposed between 1977 and 1979 in the "C Area," including VOCs, uranium, heavy metals, acids, bases, glass, waste oil, PCS capacitors, lead-acid batteries, and machine coolant. Waste may have been disposed in the "C Area" before 1977; however, waste disposal records were not maintained then. In late 1974 or early 1975, following completion of the landfill operations, K-1070-C Area became a maintenance equipment storage yard, and it is currently used to store uncontaminated maintenance equipment and materials.

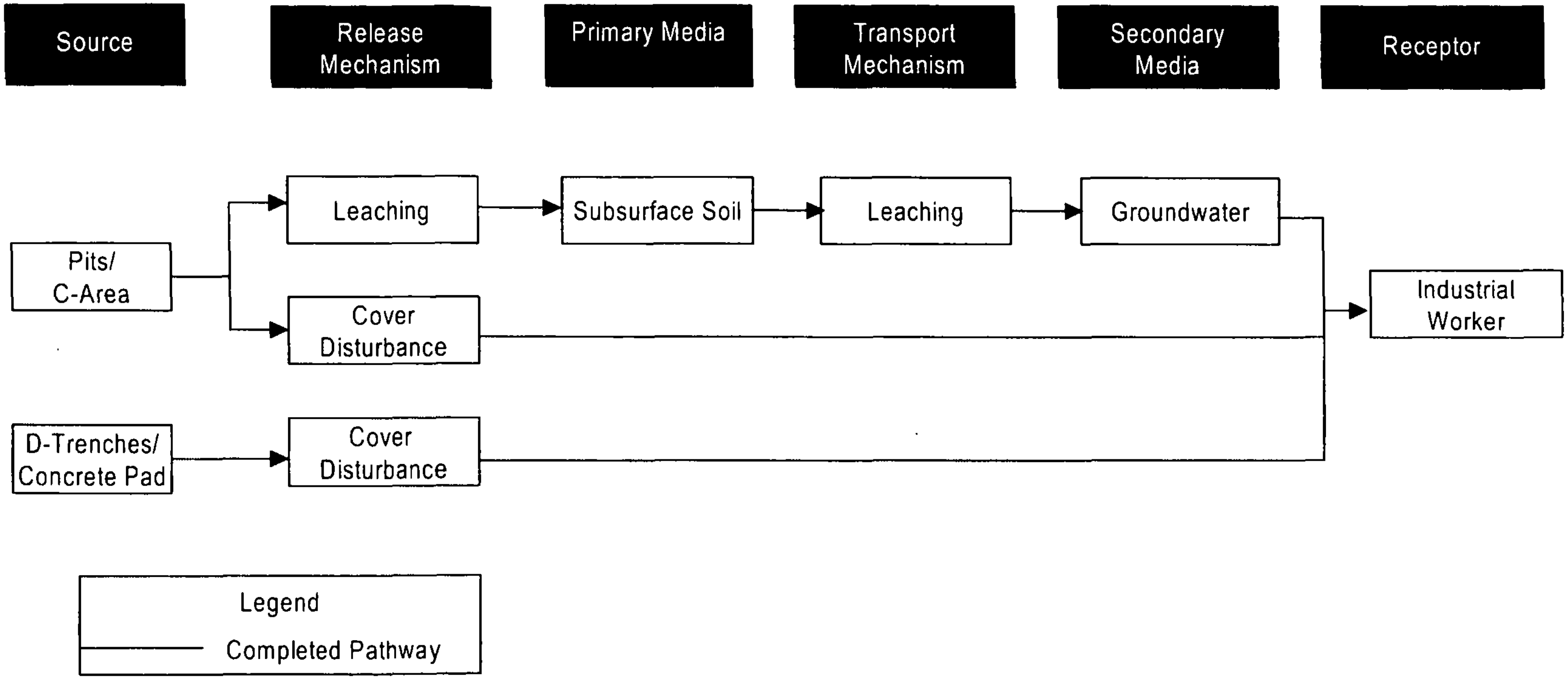

Fig. 2.10. K-1070-C/D Classified Burial Ground conceptual site model.

Burial operations began in the K-1070-D Trenches in 1976. The three large trenches, each approximately 300 feet long by 20 feet wide, were originally intended to bury low-level radioactive materials and nonradioactive, nonhazardous waste materials and equipment. The nominal depth of buried waste is estimated to be 27 feet based on historical information. After 1985, the K-1070-D Trenches (Trenches A, B, and C) received radioactive and hazardous materials from the Gas Centrifuge Program. Lead and depleted uranium weights contained in centrifuge damper assemblies, as well as miscellaneous hazardous metals from parts, were buried in Trench C. At the time of its closure, Trench C was filled to about one-third of its depth. The remaining two-thirds of Trench C were backfilled with clean earth to prepare for closure. In addition to the radioactive and hazardous materials, properly packaged asbestos was buried in the trenches until 1988. Excellent records are available that document what was disposed in the D trenches. These records indicate that disposal of both organic and inorganic solid wastes occurred at this site. Based on careful review of disposal records, most of the material disposed in the trenches was uncontaminated with the remaining waste having low levels of contamination.

Pits area. Ten pits, located on the west side of the K-1070-C/D Area, were used from 1977 to 1979 for the disposal of various hazardous wastes, including laboratory quantities of corrosives, oxidizers, reducing agents, and empty chemical and pesticide containers. The G-Pit was used for the disposal of drum quantities of various solvents and organics, including methylene chloride, Freon, and TCE. Each pit was ~ 10 feet x 20 feet x 10 to 14 feet, and the bottom portion of each pit was backfilled with sand. Additionally, at least two of these pits were used for the disposal of plastic materials and waste glass, and photo-documentation of the Pits Area indicates the presence of drum containers in the G-Pit. Based on documented disposal practices (i.e., pouring of liquid wastes into the pit) and reports of former workers, it is believed that all drum containers were emptied prior to placement in the pit. A ROD for a portion of the K-1070-C/D Operable Unit (OU) was issued in 1997 (DOE 1997e). In accordance with the ROD, waste materials in the G-Pit have been excavated, and the pit was backfilled with a concrete-mix, flowable fill material.

Concrete pad. A concrete pad, K-1071, is located on the K-1070-D Trenches. The pad (20 feet by 20 feet) is estimated to be 10 in. thick. This was the site of a compactor used for disposal of scrap metal, empty drums and boxes, and other materials. The compactor was in use from the early 1980s until its removal in 1983 or 1984. Oily stains and radioactivity present on and adjacent to the concrete pad are presumably residue associated with compacted materials and drums. In April 1999 approximately 2 feet of soil were placed over the K-1071 Concrete Pad as a CERCLA interim action. Annual radiological surveys are conducted to confirm the protectiveness of the soil cover.

Groundwater. Elevated concentrations of several metals, VOCs, and a few SVOCs have been detected in groundwater in the vicinity of the K-1070-C/D Classified Burial Ground. There is no indication of widespread radiological contamination in groundwater at this site although there are periodic exceedances of gross alpha/beta indicators above MCLs in an upgradient bedrock well and in wells downgradient of the G-Pit [Bechtel Jacobs Company, LLC (BJC) 2004a]. As reported in the Phase 2 RI for K-1070-C/D (DOE 1995), characteristic patterns of VOCs in the vicinity of K-1070-C/D suggest at least three discrete VOC source areas: (1) a trichloroethane (TCA)-dominated source in the G-Pit Area, (2) a TCE/PCE-dominated source in the K-1070-C Trench Area, and (3) a small TCE-dominated source in the northwest comer of K-1070-C/D. Elevated concentrations of 1,1,1-TCA in one well (UNW-114) screened across the K-25 fault zone suggest that free-phase DNAPL may have been present downgradient of the South Pits.

2.5.5 K-1401 FACILITY

The K-1401 Facility is located in the east-central portion of ETTP (Fig. 2.8) and was used mainly as a maintenance facility and machine shop from 1944 to 1988. Degreasing and cleaning operations began in

1944 to service parts associated with enrichment of uranium at the gaseous diffusion plant. Acids, alkalis, and organic vapor degreasers used included TCE (1940s to 1960s), TCA (from the 1970s), and carbon tetrachloride (1940s to 1950s). Acid lines were used to transfer corrosive solutions from the K-1401 Facility to the K-1407-A Neutralization Facility (DOE 1999a).

The K-1401 Acid Line was used to transfer corrosive solutions from the K-1401 Facility to the K-1407-A Neutralization Facility. The acid line is a buried, 10-in.-diameter pipeline running along the east side of the K-1401 Facility. The total length of the line is approximately 1500 feet. The waste streams that have been transported through the pipeline include degreasers, caustics, and acids used to clean equipment exposed to uranium hexafluoride (UF_6). Freon, cutting oil, aromatics, acetone, paints, epoxy, and methyl-ethyl ketones were also sent through the line. Metals included chromium (chromic acid) and mercury from instruments and containers (MMES 1991). A leak occurred in the pipeline in 1975, and the leaking portion was replaced. Subsequent leaks resulted in the entire pipeline being slip-lined with a 10-in. polyethylene sleeve in 1982. The pipeline was taken out of service in 1987 when it was found that the line continued to leak.

VOCs are the primary problematic soil constituents at the K-1401 Facility. Toluene and TCE were the most widely distributed compounds in this class of contaminants. Inorganic elements and radionuclides, while detected at above-background concentrations, do not pose a serious threat to the environment. Only three radionuclides were detected above background in K-1401 Facility soils. Technetium-99 occurred at a concentration slightly greater than twice background at one location (BJC 2004a).

Groundwater data from monitoring wells in the vicinity of the K-1401 Facility have indicated the presence of a VOC plume around and beneath the building. Samples from the K-1401 Facility wells have been analyzed for inorganic elements and compounds, limited radionuclides, VOCs, SVOCs, and PCBs. The major chemical constituent group that is problematic in groundwater at the K-1401 Facility is VOCs. Inorganic elements, radionuclides, and SVOCs are either absent or occur at low concentrations (BJC 2004a).

The VOCs detected in groundwater samples from the K-1401 Area are PCE, TCE, and their degradation products 1,1-DCE, 1,2-DCE, and vinyl chloride. Sampling of a well pair located inside of Bldg. K-1401, specifically to find a secondary source, shows no evidence for DNAPL under the eastern portion of the building. VOC concentrations in the bedrock well typically occur at low, estimated concentrations. In contrast, VOC concentrations in the paired unconsolidated well are higher, though not as high as are observed in groundwater samples collected from an unconsolidated well located outside on the east side of the building. Based on the available data, it appears that the VOC plume originating in the vicinity of Bldg. K-1401 is the result of organic chemical spills along the acid line and not a result of DNAPL beneath the building (BJC 2004a).

2.5.6 K-1004-J COMPLEX

The K-1004-J complex, located in the Administrative/Laboratories Area (Fig. 2.8), consists of several separate buildings constructed in the late 1940s as a research and development facility, which operated until 1985. Between the 1940s and 1960s, six 30-in.-diameter by 8-feet-deep vaults, located east of the K-1004-J Radiological Laboratory, and a 5500-gal underground storage tank (UST) and 6.5-feet x 6.5-feet x 12-feet pit, which housed a 750-gal "hot" tank, located to the southeast of the laboratory, were used to store radioactive materials. Materials stored included spent fuel solutions potentially containing plutonium, cesium, technetium, uranium, and other transuranics. Highly radioactive wastes that had been stored in the 750-gal tank were later taken to the K-1064 Area. During excavation activities that took place in 1998, the 5500-gal storage tank was found to contain little or no radioactivity, implying that the tank had been emptied and decontaminated. The tanks are currently posted as a subsurface radiological area. Of the six vaults used for disposing radioactive material, the locations of only two vaults have been positively identified. In addition to the routine disposals in the tanks and vaults, four known releases of uranium, including UF_6 gas, have been recorded during the K-1004-J radiochemical operation. Radiological surveys conducted inside the K-1004-J complex and adjacent areas identified several areas with elevated radioactivity. A concrete slab was poured over the vaults in 1963, the "hot" tank was reportedly removed, and around 1980 the 5500-gal storage tank was partially uncovered, filled with sand, and access lines capped and welded shut (LMES 1995, DOE 1999a).

An area of contaminated soil associated with this area is located between the K-1004-J Vaults and the K-1004-J Tanks. Available soils and groundwater data indicate that there is no residual contamination in groundwater or subsurface soils as a result of the former use of the K-1004-J Tanks. However, data from a radiological walkover survey conducted in 1994 show that surface soils in the vicinity of the tanks are contaminated with ^{l37}Cs (up to 50 pCi/g), ^{234}U (up to 12 pCi/g), and ^{238}U (up to 7 pCi/g). The presence of surface contamination in the absence of subsurface contamination indicates that the surface contamination resulted from a surface release as opposed to a subsurface leak in the tanks (BJC 2004b). The combined soil and groundwater data indicate that the K-1004-J Tanks are not a source for subsurface soil or groundwater contamination.

2.6 CURRENT AND POTENTIAL FUTURE LAND USES

In order to focus remedial planning, DOE evaluated current and reasonably anticipated future land use. This allowed DOE to propose and select remedial actions protective under these land use scenarios. Because this action does not address surface water or groundwater, water use was not evaluated. Those media, however, will be addressed in the future Site-wide ROD.

Following the shutdown of the ETTP facility, a vision statement for the future use of the facility and all associated land was developed by DOE in consultation with the FFA parties and the public. The vision statement is that ETTP becomes a commercial/industrial park with a limited DOE role and/or presence and obligations limited to those stipulated under Section 120(h) of CERCLA and for security interests. No elementary or secondary schools, playgrounds, or childcare facilities are envisioned. For any property leased, sold, or transferred, DOE will comply with the requirements of Section 120(h) of CERCLA regarding property transfer, including provisions for use restrictions and continued maintenance of LUCs that are no less restrictive than those described in this ROD.

2.6.1 CURRENT LAND USES

Zone 2 is currently under DOE control, and public access is restricted. ETTP uses a variety of institutional controls to control access to surficial and subsurface contamination. The controls include fences, guards, signs, and permits on any excavation activity. Employee training is also required to have access to fenced areas.

2.6.2 ANTICIPATED FUTURE USES

Reasonably anticipated future uses of land in Zone 2 are an important consideration in determining the types and frequencies of exposures to residual contamination and the appropriate extent of remediation. Consistent with EPA guidance, Land Use in the CERCLA Remedy Selection Process (EPA 1995a), DOE solicited input on anticipated future land use from the other FFA parties (EPA and TDEC), local land use planning authorities, and the local public. The future land use is based, in part, on this input and, in particular, on the land use recommendations of the Site-Specific Advisory Board (SSAB), now the ORSSAB EUWG (DOE 1998). The SSAB's recommendation was industrial land use for Zone 2 with part of the area available for industrial use to a depth of 10 feet and part of the area available for industrial use to a depth of 2 feet.

DOE has concluded that the reasonably anticipated future land use for ETTP Zone 2 is industrial use to a depth of 10 feet, defined as a condition that includes activities involving exposures under an industrial use scenario (2000 hours/year for 25 years) to soil and structures. This land use differs slightly from the SSAB's recommendation in that all of Zone 2 would be usable to a depth of 10 feet for industrial use. The SSAB had recommended that areas of the site near the K-1070-C/D Burial Ground be usable to a depth of 2 feet for industrial use. DOE's plan for the future use is more expansive. Zone 2 consists of areas that are being used, or were used in the past, for industrial purposes, or currently are being maintained as waste management areas. An industrial land use is a logical extension of these areas because of the availability of standard utility and transportation infrastructure. Building in floodplains (TVA 1991) and wetlands would be limited, as would construction in archeological sites (Jacobs 1995). Uses of this area that would result in greater exposure (e.g., residential or agricultural use) than those from industrial use would be prohibited. Although future land uses such as residential, recreational, or natural resource conservation were considered as potential land uses for Zone 2, each of these uses was eliminated because of the available infrastructure (barge facility, railroads, extensive roads, etc.) and interest in returning El IP to an industrial use.

2.7 SUMMARY OF SITE RISKS

The baseline risk assessment estimates the risks that the site poses to human health if no action is taken. It identifies the contaminants and exposure pathways that require action. The human health risk assessment (HHRA) for Zone 2 evaluated potential risks from exposure to surface soil and subsurface soil only; other media (e.g., groundwater and surface water) will be evaluated in subsequent CERCLA actions. The industrial worker who spends 8 hours/day outdoors was assessed as the reasonable maximally exposed receptor.

2.7.1 IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

To identify the contaminants of potential concern (COPCs), the data from the draft sitewide RI (DOE 1999a) and from subsequent Reindustrialization Program data collection efforts were assigned into the appropriate EU. An EU is the geographical area within which an anticipated receptor could move about and become exposed to a contaminated medium (during the period of the exposure duration). Receptors typically are assumed to exhibit random movement, so there is an equal probability of contacting any area within the EU. The size of the EU is appropriate for the receptor being considered. Zone 2 is composed of 44 EUs (Fig. 2.11). All of the data were then assessed for data usability. Standard screens on the data were performed to determine the COPCs. The screens used included a frequency of detection screen (contaminants never detected were not considered COPCs), a screen against industrial risk-based preliminary remediation goals (PRGs), and an evaluation of essential nutrients. The industrial PRGs were obtained from the EPA Region 9 (EPA 2002) for chemicals and from the EPA on-line PRO calculator (EPA 2003a) for radionuclides. Since there are areas of Zone 2 that have not been sampled, it is possible that additional contaminants could be identified during remedy implementation and confirmation.

Data were subdivided into two groups, surface soil (0 to 2 feet bgs) and subsurface soil (0 to 10 feet bgs). Although a risk assessment was performed at all depths to 10 feet, this division allows planners to determine the extent of excavation that may be required.

During negotiations on remediation levels between the three FFA parties, an agreement was reached to exclude the ^{226}Ra and ^{232}Th decay chain radionuclides from risk calculations because their background levels are near the top of EPA's target risk range. The need for remediation for these contaminants will be determined on the basis of a comparison with selected remediation levels. The fact that total risk exceeded the 10^{-4} risk level as a result of background levels of radium and thorium was insufficient justification to require action. To simplify the risk analysis, these contaminants were not factored into the calculations. They are, however, considered COCs, as they are present at levels above background.

2.7.2 TOXICITY ASSESSMENT

The toxicity values used in the risk assessment were slope factors for cancer risks, and reference doses (RfDs) and reference concentrations (RfCs) for systemic toxicity. Slope factors were used to quantitatively define the relationship between daily intake of a chemical and its excess lifetime cancer risk (ELCR), and RfDs and RfCs were used to quantitatively define the relationship between daily intake of a chemical and systemic toxicity. Specifically, the slope factors used in the assessment are upper-bound estimates of the probability of a response per unit intake of a carcinogen over a lifetime, and the RfDs and RfCs used in the assessment are estimates of a daily exposure level for the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. The primary sources of toxicity values were the Integrated Risk Information System (IRIS) [EPA 2003b] and the Health Effects Assessment Summary Tables (HEAST) [EPA 1997 for chemicals and EPA 2001 for radionuclides]. The toxicity values used are shown in Tables 2.1 and 2.2.

2.7.3 EXPOSURE ASSESSMENT

The exposure assessment step included the characterization of the exposure setting, the identification of exposure pathways, and the quantification of exposure. The exposure setting for Zone 2 was considered to be an industrial setting; thus, the industrial worker is the only receptor evaluated in this risk assessment. Exposure pathways included in this risk assessment were incidental ingestion of soil, dermal contact with soil, inhalation of VOCs and paniculate matter, and external exposure to radiation. Parameters for the standard industrial worker were used (e.g., workers exposed for 8 hours/day, 250 days/year, over a 25-year exposure duration) to quantify exposures. The quantification of exposure involved a determination of the mass of substance in contact with the body per unit of body weight per unit of time. For non-radiological contaminants, these exposure estimates were expressed as milligrams of chemical per kilogram of body weight per day (mg/kg-day) and are termed "intakes." The intakes were calculated for each pathway for each potential COC within each EU, using the parameters for the standard industrial worker and the representative exposure point concentration (EPC).

The EPC was determined as the smaller value between the observed maximum detected concentration and the 95% upper confidence limit (UCL_{95}) on the mean concentration. The EPCs used for key contaminants (those ultimately contributing to an ELCR above 10^{-4} and/or those with concentrations exceeding remediation levels) for soil in each EU are presented in Tables 2.3 (surface soil) and 2.4 (subsurface soil). Surface soil indicates the concentration in soil in the top 2 feet, while subsurface soil indicates the concentration in soil in the top 10 feet. In most EUs, either due to a lack of data or due to a lack of subsurface contamination, the EPC is the same for either surface or subsurface.

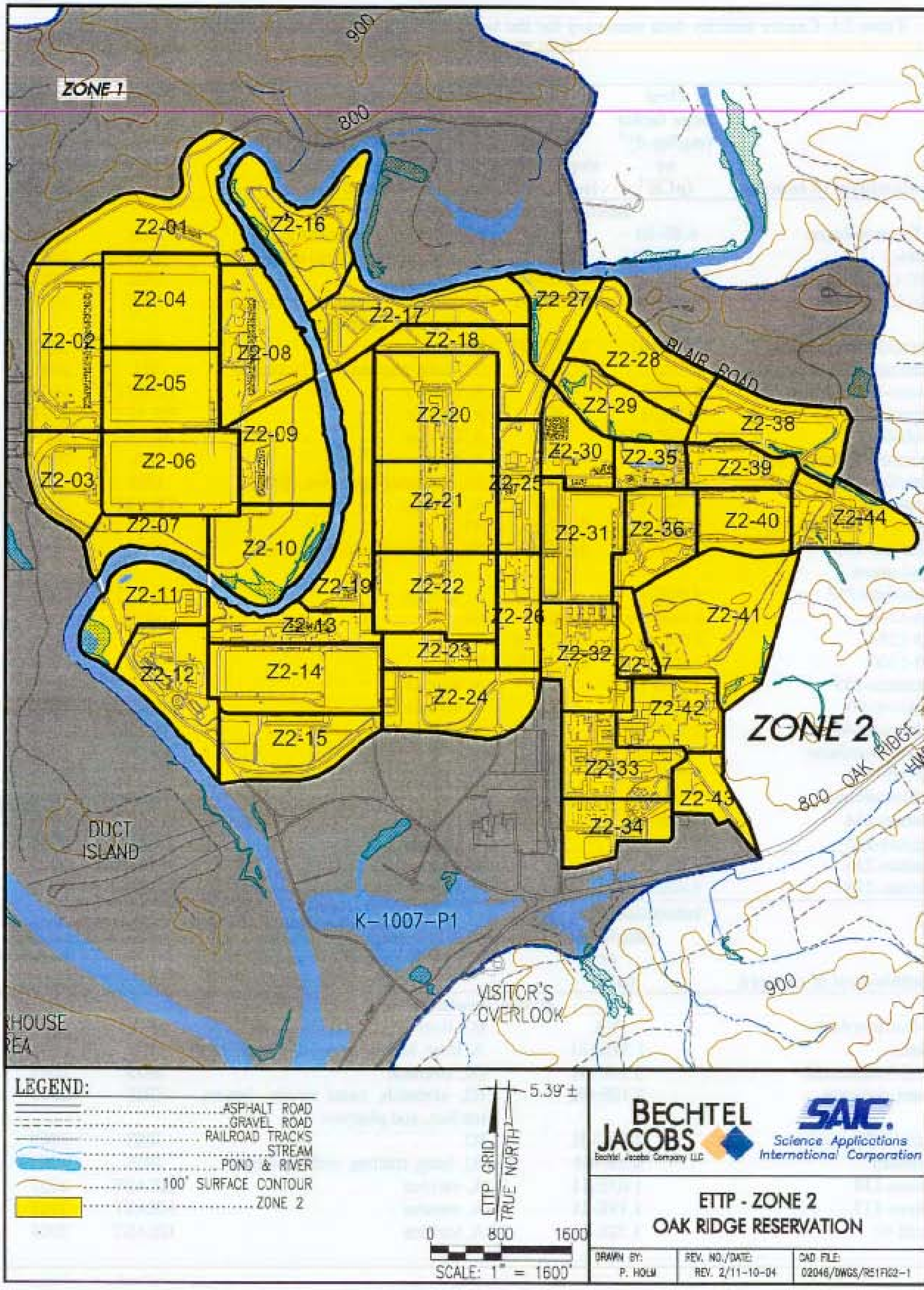

Fig. 2.11. ETTP Zone 2 exposure units.

Table 2.1. Cancer toxicity data summary for the human health risk assessment for ETTP Zone 2 soils, Oak Ridge, Tennessee

Contaminant of concern	Oral slope factor (mg/kg-d)$^{-1}$ or (pCi)$^{-1}$	Dermal slope factor (mg/kg-d)$^{-1}$	Weight of evidence/ types of cancer	Source	Date accessed
		Route: Ingestion and dermal contact			
2,4-Dinitrotoluene	6.8E-01	8.0E-01	B2, liver and mammary gland	IRIS	2003
Arsenic	1.5E+00	3.66E+00	A, liver, kidney, lung, and bladder	IRIS	2003
Benz(*a*)anthracene	7.30E-01	2.35E+00	B2, stomach	IRIS	2003
Benzo(*a*)pyrene	7.30E+00	2.35E+01	B2, stomach, nasal cavity, larynx, trachea, and pharynx	IRIS	2003
Benzo(*b*)fluoranthene	7.30E-01	2.35E+00	B2	IRIS	2003
Cadmium	NA	NA	B1, lung, trachea, and bronchus	NA	2003
Cesium-134	4.48E-11	NA	A, various	HEAST	2003
Cesium-137	3.17E-11	NA	A, various	HEAST	2003
Cobalt-60	7.33E-12	NA	A, various	HEAST	2003
Chromium (hexavalent)	NA	NA	A, lung	NA	2003
Dibenz(*a,h*)anthracene	7.30E+00	2.35E+01	B2, immunodepressive effects	IRIS	2003
Europium-154	4.74E-12	NA	A, various	HEAST	2003
Indeno(1,2,3-*cd*)pyrene	7.30E-01	2.35E+00	B2	IRIS	2003
N-Nitroso-di-n-propylamine	7.00E+00	2.80E+01	B2, hepatocellular carcinomas	IRIS	2003
Neptunium-237	4.92E-11	NA	A, various	HEAST	2003
PCB-1248	2.00E+00	2.22E+00	B2	IRIS	2003
PCB-1254	2.00E+00	2.22E+00	B2	IRIS	2003
PCB-1260	2.00E+00	2.22E+00	B2	IRIS	2003
Plutonium-239	1.21E-10	NA	A, various	HEAST	2003
Strontium-90	5.92E-11	NA	A, various	HEAST	2003
Technetium-99	1.32E-12	NA	A, various	HEAST	2003
Tetrachloroethene	5.2E-02	5.2E-02	NA	PROV	2003
Thorium-230	7.73E-11	NA	A, various	HEAST	2003
Trichloroethene	1.10E-02	7.33E-02	NA	PROV	2003
Uranium-234	5.11E-11	NA	A, various	HEAST	2003
Uranium-235	5.03E-11	NA	A, various	HEAST	2003
Uranium-236	4.85E-11	NA	A, various	HEAST	2003
Uranium-238	5.62E-11	NA	A, various	HEAST	2003

Contaminant of concern	Inhalation slope factor (mg/kg-d)$^{-1}$ or (pCi)$^{-1}$	Weight of evidence/ types of cancer	Source	Date accessed
		Route: Inhalation		
2,4-Dinitrotoluene	NA	B2, liver and mammary gland	NA	2003
Arsenic	1.51E+01	A, liver, kidney, lung, and bladder	IRIS	2003
Benz(*a*)anthracene	3.10E-01	B2, stomach	IRIS	2003
Benzo(*a*)pyrene	3.10E+00	B2, stomach, nasal cavity, larynx, trachea, and pharynx	IRIS	2003
Benzo(*b*)fluoranthene	3.10E-01	B2	IRIS	2003
Cadmium	6.3E+00	B1, lung, trachea, and bronchus	IRIS	2003
Cesium-134	1.65E-11	A, various	HEAST	2003
Cesium-137	1.19E-11	A, various	HEAST	2003
Cobalt-60	3.58E-11	A, various	HEAST	2003

Table 2.1. Cancer toxicity data summary for the human health risk assessment for ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Contaminant of concern	Inhalation slope factor $(mg/kg\text{-}d)^{-1}$ or $(pCi)^{-1}$	Weight of evidence/ types of cancer	Source	Date accessed
		Route: Inhalation		
Chromium (hexavalent)	4.20E+01	A, lung	IRIS	2003
Dibenz(*a,h*)anthracene	3.10E+00	B2, immunodepressive effects	IRIS	2003
Europium-154	1.15E-10	A, various	HEAST	2003
Indeno(1,2,3-*cd*)pyrene	3.10E-01	B2	IRIS	2003
N-Nitroso-di-n-propylamine	NA	B2, hepatocellular carcinomas	NA	2003
Neptunium-237	1.77E-08	A, various	HEAST	2003
PCB-1248	2.00E+00	B2	IRIS	2003
PCB-1254	2.00E+00	B2	IRIS	2003
PCB-1260	2.00E+00	B2	IRIS	2003
Plutonium-239	3.33E-08	A, various	HEAST	2003
Strontium-90	1.13E-10	A, various	HEAST	2003
Technetium-99	1.41E-11	A, various	HEAST	2003
Tetrachloroethene	2.00E-03	NA	PROV	2003
Thorium-230	2.85E-08	A, various	HEAST	2003
Trichloroethene	6.00E-03	NA	PROV	2003
Uranium-234	1.14E-08	A, various	HEAST	2003
Uranium-235	1.01E-08	A, various	HEAST	2003
Uranium-236	1.05E-08	A, various	HEAST	2003
Uranium-238	9.35E-09	A, various	HEAST	2003

Contaminant of concern	External slope factor $(pCi\text{-}year/g)^{-1}$	Weight of evidence/ types of cancer	Source	Date accessed
		Route: External exposure		
Cesium-134	7.10E-06	A, various	HEAST	2003
Cesium-137	2.55E-06	A, various	HEAST	2003
Cobalt-60	1.24E-05	A, various	HEAST	2003
Europium-154	5.83E-06	A, various	HEAST	2003
Neptunium-237	7.97E-07	A, various	HEAST	2003
Plutonium-239	2.00E-10	A, various	HEAST	2003
Strontium-90	1.96E-08	A, various	HEAST	2003
Technetium-99	8.14E-11	A, various	HEAST	2003
Thorium-230	8.19E-10	A, various	HEAST	2003
Uranium-234	2.52E-10	A, various	HEAST	2003
Uranium-235	5.43E-07	A, various	HEAST	2003
Uranium-236	1.25E-10	A, various	HEAST	2003
Uranium-238	1.14E-07	A, various	HEAST	2003

Note: This table provides carcinogenic risk information that is relevant to the COCs for all routes of exposure over all COCs identified in ETTP Zone 2 soils. In this table, the slope factors for dermal contact were extrapolated from oral values using adjustment factors based upon the absorption that occurs in the gut

A = human carcinogen.

B2 = probable human carcinogen—sufficient evidence for animals but inadequate or no evidence from humans.

COC = contaminant of concern.

ETTP = East Tennessee Technology Park.

HEAST = Health Effects Assessment Summary Tables, U. S. Environmental Protection Agency (EPA) [EPA 1997 for chemicals and EPA 2001 for radionuclides].

IRIS = Integrated Risk Information System (EPA 2003b).

NA = no information available.

PCB = polychlorinated biphenyl.

PROV = Provisional value from National Center for Environmental Assessment used; values shown on Risk Assessment Information System, maintained by the University of Tennessee for the Oak Ridge National Laboratory (ORNL 2003).

Table 2.2. Noncancer toxicity data summary for the human health risk assessment for ETTP Zone 2 soils, Oak Ridge, Tennessee

Contaminant of concern	Oral RfD (mg/kg-d)	Dermal RfD (mg/kg-d)	Primary target organ	Combined uncertainty/ modifying factors	Source	Date accessed
			Route: Ingestion, dermal			
1,2-Dichloroethene	9.00E-03	7.20E-03	NA	NA	HEAST	2003
2,4-Dinitrotoluene	2.00E-03	1.70E-03	Liver	100	IRIS	2003
Arsenic	3.00E-04	1.23E-04	Skin	3	IRIS	2003
Cadmium	1.00E-03	1.00E-05	Kidney	1000	IRIS	2003
Chromium (hexavalent)	3.00E-03	6.00E-05	Liver	100	IRIS	2003
Copper	4.00E-02	1.20E-02	NA	NA	HEAST	2003
Iron	3.00E-01	4.50E-02	NA	NA	PROV	2003
Manganese	4.60E-02	1.84E-03	Central nervous system	3	IRIS	2003
Mercury	3.00E-04	2.10E-05	Neurotoxicity	300	IRIS	2003
Nickel	2.00E-02	5.40E-03	Body weight	100	IRIS	2003
Nitrate	1.60E+00	8.00E-01	Blood	1	IRIS	2003
PCB-1254	2.00E-05	1.80E-05	Immune system	300	IRIS	2003
Tetrachloroethene	1.00E-02	1.00E-02	Liver	1000	IRIS	2003
Thallium	8.00E-05	4.00E-05	Blood	3000	IRIS	2003
Trichloroethene	6.00E-03	9.00E-04	NA	NA	PROV	2003
Uranium	6.00E-04	5.10E-04	Body weight	1000	IRIS	2003

Contaminant of concern	Inhalation RfC $(mg/kg\text{-}d)^{-1}$	Primary target organ	Combined uncertainty/ modifying factors	Source	Date accessed
		Route: Inhalation			
1,2-Dichloroethene	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA
Chromium (hexavalent)	2.86E-05	Lung	300	IRIS	2003
Copper	NA	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA
Manganese	1.43E-05	Nervous system	1000	IRIS	2003
Mercury	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA
Nitrate	NA	NA	NA	NA	NA
PCB-1254	NA	NA	NA	NA	NA
Tetrachloroethene	1.71E-01	NA	NA	PROV	2003
Thallium	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	NA

Note: This table provides noncarcinogenic risk information that is relevant to the contaminants of concern (COCs) for all routes of exposure over all COCs identified in ETTP Zone 2 soils. As with carcinogenic data, dermal RfDs were extrapolated from oral RfDs applying an adjustment factor based upon absorption from the gut.

ETTP = East Tennessee Technology Park.
IRIS = Integrated Risk Information System, U. S. Environmental Protection Agency (EPA 2003b).
NA = no information available.
PCB = polychlorinated biphenyl.
RfC = reference concentration.
RfD = reference dose.
PROV = Provisional value from the National Center for Environmental Assessment used; values shown on Risk Assessment Information System, maintained by the University of Tennessee for the Oak Ridge National Laboratory (ORNL 2003).

Table 2.3. Summary of COCs and exposure point concentrations for surface soil (0–2 feet) under future conditions (i.e., industrial use), ETTP Zone 2, Oak Ridge, Tennessee

Scenario timeframe: Future
Medium: Soil
Exposure medium: Surface soil

Exposure point	COC	Concentration detected Min	Concentration detected Max	Concentration detected Units	Frequency of detection	EPC	Percent total risk	Percent total hazard	Statistical measure
Z2-01	None - EU risk < 10^{-4} and HI < 1								
Z2-02	None - EU risk < 10^{-4} and HI < 1								
Z2-03	None - EU risk < 10^{-4} and HI < 1								
Z2-04	None - No COPCs								
Z2-05	None - EU risk < 10^{-4} and HI < 1								
Z2-06	None - EU risk < 10^{-4} and HI < 1								
Z2-07	None - No data								
Z2-08	None - EU risk < 10^{-4} and HI < 1								
Z2-09	None - EU risk < 10^{-4} and HI < 1								
Z2-10	None - EU risk < 10^{-4} and HI < 1								
Z2-11	None - EU risk < 10^{-4} and HI < 1								
Z2-12	None - EU risk < 10^{-4} and HI < 1								
Z2-13	Uranium-235	0.0897	380	pCi/g	15/19	58	22.14		UCL_{95}(N)
	Uranium-238	0.128	895	pCi/g	19/19	895	73.46		MAX(L)
Z2-14	None - EU risk < 10^{-4} and HI < 1								
Z2-15	None - EU risk < 10^{-4} and HI < 1								
Z2-16	Uranium-235	0.0413	490	pCi/g	33/42	40.6	30.64		UCL_{95}(N)
	Uranium-238	0.712	4660	pCi/g	39/43	369	59.88		UCL_{95}(N)
Z2-17	None - EU risk < 10^{-4} and HI < 1[a]								
Z2-18	None - EU risk < 10^{-4} and HI < 1								
Z2-19	Cesium-137	0.192	255	pCi/g	25/37	45.2	15.62		UCL_{95}(L)
	Neptunium-237	0.21	230	pCi/g	8/36	28.1	4.01		UCL_{95}(N)
	Uranium-234	1.1	75000	pCi/g	35/36	5850	3.52		UCL_{95}(N)
	Uranium-235	0.27	6900	pCi/g	26/36	533	51.89		UCL_{95}(N)
	Uranium-238	1	3600	pCi/g	36/36	1180	24.70		UCL_{95}(L)
Z2-20	None - EU risk < 10^{-4} and HI < 1								
Z2-21	None - EU risk < 10^{-4} and HI < 1								
Z2-22	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-23	None - EU risk < 10^{-4} and HI < 1								
Z2-24	None - EU risk < 10^{-4} and HI < 1								
Z2-25	Cesium-137	1.65	33.4	pCi/g	2/3	33.4	17.50		MAX(N)
	Uranium-235	91.5	133	pCi/g	2/3	133	19.63		MAX(N)
	Uranium-238	0.413	1850	pCi/g	3/3	1850	58.73		MAX(N)
Z2-26	None - EU risk < 10^{-4} and HI < 1								
Z2-27	PCB-1254	0.46	10	mg/kg	5/5	10	21.26	87.45	MAX(L)

Table 2.3. Summary of COCs and exposure point concentrations for surface soil (0–2 feet) under future conditions (i.e., industrial use), ETTP Zone 2, Oak Ridge, Tennessee (continued)

Scenario timeframe: Future
Medium: Soil
Exposure medium: Surface soil

Exposure point	COC	Concentration detected Min	Max	Units	Frequency of detection	EPC	Percent total risk	Percent total hazard	Statistical measure
Z2-28	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-29	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-30	Uranium-235	0.111	319	pCi/g	17/24	55.4	61.33		UCL_{95}(N)
Z2-31	Cadmium	0.69	48.3	mg/kg	4/5	32.6	0.00	61.84	UCL_{95}(N)
	Uranium-238	0.292	210	pCi/g	5/5	210	71.29		MAX(L)
Z2-32	None - EU risk < 10^{-4} and HI < 1								
Z2-33	Cesium-137	0.155	49.6	pCi/g	15/16	16.4	47.37		UCL_{95}(N)
Z2-34	None - No data								
Z2-35	None - EU risk < 10^{-4} and HI < 1								
Z2-36	None - EU risk < 10^{-4} and HI < 1								
Z2-37	None - EU risk < 10^{-4} and HI < 1								
Z2-38	None - EU risk < 10^{-4} and HI < 1								
Z2-39	Uranium-235	0.121	1340	pCi/g	46/73	89.3	55.05		UCL_{95}(N)
Z2-40	None - EU risk < 10^{-4} and HI < 1								
Z2-41	Uranium-238	0.0675	15700	pCi/g	59/76	593	88.65		UCL_{95}(N)
Z2-42	Cesium-137	0.0685	444	pCi/g	8/13	96.6	99.02		UCL_{95}(N)
Z2-43	None - No data								
Z2-44	None - EU risk < 10^{-4} and HI < 1								

Notes: This table presents COCs and EPCs for each of the COCs detected in soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in samples collected at the site), the EPC, and how the EPC was derived (statistical measure). Only COCs with total risk > 10^{-4} and total hazard > 1.0 are shown.

The table indicates that the most common class of contaminants detected in soil was radionuclides and that the majority of the total risk for an industrial worker (i.e., total excess lifetime cancer risk) was due to exposure to radionuclides.

% Total risk = excess lifetime cancer risk due to exposure to the single analyte divided by risk from exposure to all contaminants in soil. Note that the sum of all percentages may not equal 100% due to rounding error.

% Total hazard = noncarcinogenic hazard due to exposure to the single analyte divided by total hazard index from exposure to all contaminants in soil. Note that the sum of all percentages may not equal 100% due to rounding error.

[a]For Z2-17, the total hazard index (HI) across all contaminants is > 1; however, the HIs for all individual contaminants are < 1.
[b]For Z2-22, -28, and -29, the total risk across all contaminants is >10^{-4}; however, the total risks for all individual contaminants are < 10^{-4}.

COC = contaminant of concern.
COPC = contaminant of potential concern.
EPC = exposure point concentration.
ETTP = East Tennessee Technology Park.
EU = exposure unit.
HI = hazard index.
Max = maximum detected concentration.
Z2 = Zone 2.
MAX(L) = EPC is the maximum detected concentration of a log normal distribution.
MAX(N) = EPC is the maximum detected concentration of a normal distribution.
Min = minium detected concentration.
PCB = polychlorinated biphenyl.
UCL_{95}(L) = EPC is the 95% upper confidence level on the mean concentration of a log normal distribution.
UCL_{95}(N) = EPC is the 95% upper confidence level on the mean concentration of a normal distribution.

Table 2.4. Summary of COCs and exposure point concentrations for subsurface soil (0–10 feet) under future conditions (i.e., industrial use), ETTP Zone 2, Oak Ridge, Tennessee

Scenario timeframe: Future
Medium: Soil
Exposure medium: Subsurface soil

Exposure point	COC	Concentration detected Min	Max	Units	Frequency of detection	EPC	Percent total risk	Percent total hazard	Statistical measure
Z2-01	None - EU risk < 10^{-4} and HI < 1								
Z2-02	None - EU risk < 10^{-4} and HI < 1								
Z2-03	None - EU risk < 10^{-4} and HI < 1								
Z2-04	None - No COPCs								
Z2-05	None - EU risk < 10^{-4} and HI < 1								
Z2-06	None - EU risk < 10^{-4} and HI < 1								
Z2-07	None - No data								
Z2-08	None - EU risk < 10^{-4} and HI < 1								
Z2-09	None - EU risk < 10^{-4} and HI < 1								
Z2-10	None - EU risk < 10^{-4} and HI < 1								
Z2-11	None - EU risk < 10^{-4} and HI < 1								
Z2-12	None - EU risk < 10^{-4} and HI < 1								
Z2-13	Uranium-235	0.0897	380	pCi/g	16/23	47.7	19.00		UCL_{95}(N)
	Uranium-238	0.128	895	pCi/g	23/23	895	76.68		MAX(L)
Z2-14	None - EU risk < 10^{-4} and HI < 1								
Z2-15	None - EU risk < 10^{-4} and HI < 1								
Z2-16	Uranium-235	0.0413	490	pCi/g	33/42	40.6	30.64		UCL_{95}(N)
	Uranium-238	0.712	4660	pCi/g	39/43	369	59.88		UCL_{95}(N)
Z2-17	None - EU risk < 10^{-4} and HI < 1[a]								
Z2-18	None - EU risk < 10^{-4} and HI < 1								
Z2-19	Cesium-137	0.192	255	pCi/g	25/43	24.4	11.12		UCL_{95}(N)
	Uranium-235	0.27	6900	pCi/g	26/42	456	58.53		UCL_{95}(N)
	Uranium-238	1	3600	pCi/g	41/42	780	21.53		UCL_{95}(L)
Z2-20	None - EU risk < 10^{-4} and HI < 1								
Z2-21	None - EU risk < 10^{-4} and HI < 1								
Z2-22	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-23	None - EU risk < 10^{-4} and HI < 1								
Z2-24	None - EU risk < 10^{-4} and HI < 1								
Z2-25	Uranium-238	0.286	1850	pCi/g	14/15	416	58.65		UCL_{95}(N)
Z2-26	None - EU risk < 10^{-4} and HI < 1								
Z2-27	PCB-1254	0.46	10	mg/kg	5/5	10	21.26	87.45	MAX(L)
Z2-28	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-29	None - EU risk < 10^{-4} and HI < 1[b]								
Z2-30	Uranium-235	0.111	319	pCi/g	17/24	55.4	61.33		UCL_{95}(N)
Z2-31	None - EU risk < 10^{-4} and HI < 1								
Z2-32	None - EU risk < 10^{-4} and HI < 1								
Z2-33	Cesium-137	0.155	49.6	pCi/g	15/20	13.2	47.06		UCL_{95}(N)

Table 2.4. Summary of COCs and exposure point concentrations for subsurface soil (0–10 feet) under future conditions (i.e., industrial use), ETTP Zone 2, Oak Ridge, Tennessee (continued)

Scenario timeframe: Future
Medium: Soil
Exposure medium: Subsurface soil

Exposure point	COC	Concentration detected Min	Max	Units	Frequency of detection	EPC	Percent total risk	Percent total hazard	Statistical measure
Z2-34	None - No data								
Z2-35	None - EU risk < 10^{-4} and HI < 1								
Z2-36	None - EU risk < 10^{-4} and HI < 1								
Z2-37	None - EU risk < 10^{-4} and HI < 1								
Z2-38	None - EU risk < 10^{-4} and HI < 1								
Z2-39	Uranium-235	0.121	1340	pCi/g	59/122	54.9	52.83		$UCL_{95}(N)$
Z2-40	None - EU risk < 10^{-4} and HI < 1								
Z2-41	Uranium-238	0.0675	15700	pCi/g	77/123	366	88.20		$UCL_{95}(N)$
Z2-42	Cesium-137	0.0685	444	pCi/g	8/18	68.8	98.81		$UCL_{95}(N)$
Z2-43	None - No data								
Z2-44	None - EU risk < 10^{-4} and HI < 1								

Notes: This table presents COCs and EPCs for each of the COCs detected in soil (i.e., the concentration that was used to estimate the exposure and risk from each COC in soil). The table includes the range of concentrations detected for each COC, as well as the frequency of detection (i.e., the number of times the chemical was detected in samples collected at the site), the EPC, and how the EPC was derived (statistical measure). Only COCs with total risk > 10^{-4} and total hazard > 1.0 are shown.

The table indicates that the most common class of contaminants detected in soil was radionuclides and that the majority of the total risk for an industrial worker (i.e., total excess lifetime cancer risk) was due to exposure to radionuclides.

% Total risk = excess lifetime cancer risk due to exposure to the single analyte divided by risk from exposure to all contaminants in soil. Note that the sum of all percentages may not equal 100% due to rounding error.

% Total hazard = noncarcinogenic hazard due to exposure to the single analyte divided by total hazard index from exposure to all contaminants in soil. Note that the sum of all percentages may not equal 100% due to rounding error.

[a]For Z2-17, the total hazard index (HI) across all contaminants is > 1; however, the HIs for all individual contaminants are < 1.
[b]For Z2-22, -28, and -29, the total risk across all contaminants is >10^{-4}; however, the total risks for all individual contaminants are < 10^{-4}.

COC = contaminant of concern.
COPC = contaminant of potential concern.
EPC = exposure point concentration.
ETTP = East Tennessee Technology Park.
EU = exposure unit.
HI = hazard index.
Max = maximum detected concentration.
MAX(L) = EPC is the maximum detected concentration of a log normal distribution.
Min = minimum detected concentration.
PCB = polychlorinated biphenyl.
$UCL_{95}(L)$ = EPC is the 95% upper confidence level on the mean concentration of a log normal distribution.
$UCL_{95}(N)$ = EPC is the 95% upper confidence level on the mean concentration of a normal distribution.
Z2 = Zone 2.

2.7.4 RISK CHARACTERIZATION

This section describes how the outputs from the exposure assessment (i.e., doses) and toxicity assessment (toxicity values) are combined to characterize the baseline risks. As with the earlier sections, most information is presented in tables. This section concludes with a short discussion of the uncertainties affecting the results of the baseline HHRA.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime because of exposure to the carcinogen. ELCR is calculated from the following equation:

$$\text{Risk} = \text{GDI} \times \text{SF},$$

where

Risk = the increased probability of an individual developing cancer over a lifetime,
GDI = chronic daily intake averaged over a 70-year lifetime (mg/kg-day), pCi, or [pCi-year/g],
SF = slope factor, a measure of carcinogenicity (see Table 2.1), ($[\text{mg/kg-day}]^{-1}$), $[\text{pCi}]^{-1}$, or $[\text{pCi-year/g}]^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An ELCR of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure (RME) estimate has a 1-in-l million chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes, such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's target risk range for site-related exposures is 1×10^{-4} to 1×10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specific time period (e.g., lifetime) with an RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ <1 indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic noncarcinogenic effects from the chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver), or that act through the same mechanism of action within a medium or across all media to which a given individual may be reasonably exposed. An HI <1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI >1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\textit{Non-cancer HQ} = \textit{GDI} \div \textit{RfD},$$

where

GDI = chronic daily intake,
RfD = reference dose.

GDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

In the HHRA, performed to evaluate Zone 2 soils, the carcinogenic risks were summed across all exposure pathways and across all COPCs to determine a total risk estimate for each EU. Likewise, the noncarcinogenic HQs were summed across all exposure pathways and across all noncarcinogenic COPCs to determine an HI for each EU. Total risk and HI were determined for both surface soil exposures and for subsurface soil exposure. COCs were then determined based on EPA Region 4 guidance (EPA 2000). When the total risk across all COPCs is at least 1×10^{-4}, then any individual contaminant with risk $>1 \times 10^{-6}$ is a carcinogenic COC. When the HI (across all COPCs) is at least 1.0, then any individual contaminant with a hazard >0.1 is a noncarcinogenic COC. Based on availability of data and the presence of COCs, risks and hazards were quantified for most of the 44 EUs. The results are presented in Table 2.5.

2.7.5 CONCLUSIONS

As shown in Table 2.5, the risk assessment on the soils in Zone 2 indicates that 13 EUs have a risk greater than 10^{-4}. Further analysis reveals that 4 EUs (Z2-17, Z2-25, Z2-27, and Z2-31) have an HI that exceeds 1, with surface soil HI values ranging from 1.2 to 1.9 for these EUs. The only COC with an HI that exceeds 1 is PCB-1254 (HI-1.3 at Z2-27).

The COCs are primarily radionuclides; however, arsenic, cadmium, chromium, copper, iron, mercury, nickel, total uranium, or PCBs were identified as COCs in four of the EUs. The primary exposure pathway contributing to the total risk is external exposure to radiation. This pathway made up at least 87% of the total risk in 12 of the 13 EUs with risk above 10^{-4}. Table 2.6 shows the percentage of total risk attributable to external radiation exposure for these EUs. The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

2.8 REMEDIAL ACTION OBJECTIVES

RAOs provide a general description of what the cleanup will accomplish. This section outlines the RAO selected for Zone 2 (Table 2.7), provides a basis and rationale for the RAO, and describes how the RAO addresses risks identified in the risk assessment. The RAO addresses the protection of human health from soil, buried material, and subsurface structure contamination. It also addresses the protection of groundwater. Based on relevant guidance and site-specific information, this RAO is consistent with the NCP's requirements [40 CFR 300.430(e)(2)(I)(A)] for protective remediation goals.

The reasonably anticipated future land use for HTTP Zone 2 is industrial. The RAO is to protect human health under an industrial land use by not exceeding the target risk range, excluding radium and thorium, and an HI of less than 1. For systemic toxicants, acceptable exposure levels represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety. Based on EPA Region 4 supplemental *Risk Assessment Guidance for Superfund* (EPA 1995b) and site-specific conditions, an HI of 1 was selected to be protective of human health. If the HI exceeds 1, target organ His are calculated. If they exceed 1, a risk management decision is made whether or not to take action.

The RAO associated with groundwater resources is to minimize further contamination of groundwater at levels exceeding MCLs. The intent of this goal is to remediate contaminated subsurface soils or buried wastes that have a potential to cause groundwater contamination at levels that would exceed MCLs. MCLs are considered potential ARARs for groundwater. To prevent this action from being inconsistent with a future groundwater decision in the Site-wide ROD, the MCL was selected as the basis for the RAO. At EPA's request, two contaminants (^{237}Np and ^{239}Pu) without MCLs were added to the list of considered contaminants. If they are found in the soil, they would be remediated if their presence could cause a future unacceptable residential risk in groundwater.

Table 2.5. Summary of the number of locations with data and carcinogenic risk calculations for soils, ETTP Zone 2, Oak Ridge, Tennessee

Exposure unit[a]	EU size (acres)	Number of locations with surface soil data[b]	Number of locations with subsurface soil data[c]	Risk calculations (excluding ^{226}Ra and ^{232}Th)[d]					
				Surface soil[b]			Subsurface soil[c]		
				Chemical risk	Radiological risk	Total risk (Chem + Rad)	Chemical risk	Radiological risk	Total risk (Chem + Rad)
Z2-01	30	7	7	No COPCs	8.9E-06	8.9E-06	No COPCs	8.9E-06	8.9E-06
Z2-02	29	30	30	5.2E-05	2.7E-05	7.9E-05	5.2E-05	2.7E-05	7.9E-05
Z2-03	15	16	16	5.3E-06	1.3E-05	1.8E-05	5.3E-06	1.3E-05	1.8E-05
Z2-04	25	1	1	No COPCs	No COPCs	No COPCs	No COPCs	No COPCs	No COPCs
Z2-05	22	4	4	No COPCs	1.6E-05	1.6E-05	No COPCs	1.6E-05	1.6E-05
Z2-06	26	3	3	No COPCs	2.4E-05	2.4E-05	No COPCs	2.4E-05	2.4E-05
Z2-08	24	19	19	No COPCs	2.6E-05	2.6E-05	No COPCs	2.6E-05	2.6E-05
Z2-09	21	7	7	1.6E-06	2.0E-05	2.2E-05	1.6E-06	2.0E-05	2.2E-05
Z2-10	21	1	1	1.4E-06	7.1E-06	8.5E-06	1.4E-06	7.1E-06	8.5E-06
Z2-11	18	4	4	1.1E-05	3.0E-06	1.4E-05	1.1E-05	3.0E-06	1.4E-05
Z2-12	20	20	20	6.1E-06	7.5E-06	1.4E-05	1.0E-05	7.5E-06	1.8E-05
Z2-13	13	23	27	7.9E-07	7.3E-04	7.3E-04	1.1E-06	7.0E-04	7.0E-04
Z2-14	27	8	8	2.1E-06	1.7E-05	2.0E-05	2.4E-06	1.7E-05	2.0E-05
Z2-15	20	4	4	1.6E-06	9.5E-06	1.1E-05	1.6E-06	9.5E-06	1.1E-05
Z2-16	24	43	46	4.5E-06	3.7E-04	3.7E-04	4.5E-06	3.7E-04	3.7E-04
Z2-17	23	3	4	2.4E-05	4.2E-05	6.6E-05	2.2E-05	4.2E-05	6.4E-05
Z2-18	16	1	1	No COPCs	1.5E-05	1.5E-05	No COPCs	1.5E-05	1.5E-05
Z2-19	21	38	42	1.8E-06	2.9E-03	2.9E-03	1.8E-06	2.2E-03	2.2E-03
Z2-20	30	14	15	No COPCs	5.6E-05	5.6E-05	3.0E-06	5.3E-05	5.6E-05
Z2-21	26	2	5	No COPCs	1.2E-05	1.2E-05	1.7E-06	8.4E-06	1.0E-05
Z2-22	23	12	12	1.8E-06	1.2E-04	1.2E-04	1.8E-06	1.2E-04	1.2E-04

Table 2.5. Summary of the number of locations with data and carcinogenic risk calculations for soils, ETTP Zone 2, Oak Ridge, Tennessee (continued)

				Risk calculations (excluding ^{226}Ra and ^{232}Th)[d]					
				Surface soil[b]			Subsurface soil[c]		
Exposure unit[a]	EU size (acres)	Number of locations with surface soil data[b]	Number of locations with subsurface soil data[c]	Chemical risk	Radiological risk	Total risk (Chem + Rad)	Chemical risk	Radiological risk	Total risk (Chem + Rad)
Z2-23	8	3	3	1.2E-06	8.0E-06	9.2E-06	1.2E-06	8.0E-06	9.2E-06
Z2-24	22	2	3	No COPCs	5.0E-06	5.0E-06	1.2E-06	5.0E-06	6.2E-06
Z2-25	13	3	10	1.1E-05	1.9E-03	1.9E-03	5.0E-06	4.2E-04	4.3E-04
Z2-26	11	4	4	5.2E-06	1.7E-06	6.9E-06	5.2E-06	1.7E-06	6.9E-06
Z2-27	12	4	4	3.6E-05	5.0E-05	8.6E-05	3.6E-05	5.0E-05	8.6E-05
Z2-28	20	32	32	5.1E-06	1.3E-04	1.4E-04	5.1E-06	1.3E-04	1.4E-04
Z2-29	14	23	23	9.3E-05	4.0E-05	1.3E-04	9.3E-05	3.7E-05	1.3E-04
Z2-30	12	25	25	2.0E-06	2.5E-04	2.5E-04	2.0E-06	2.5E-04	2.5E-04
Z2-31	21	5	17	5.6E-06	1.7E-04	1.8E-04	2.1E-06	2.5E-05	2.7E-05
Z2-32	18	19	25	5.3E-06	5.6E-06	1.1E-05	8.8E-06	5.5E-06	1.4E-05
Z2-33	18	20	25	1.0E-05	3.3E-04	3.4E-04	7.5E-06	2.7E-04	2.8E-04
Z2-35	8	10	13	3.6E-06	9.7E-07	4.6E-06	2.0E-06	2.2E-06	4.2E-06
Z2-36	15	16	16	2.3E-05	1.1E-05	3.4E-05	2.3E-05	1.1E-05	3.4E-05
Z2-37	6	20	34	4.9E-06	5.9E-06	1.1E-05	4.1E-06	4.6E-06	8.7E-06
Z2-38	20	13	13	3.3E-06	7.1E-06	1.0E-05	3.3E-06	7.1E-06	1.0E-05
Z2-39	10	73	84	1.5E-05	4.4E-04	4.6E-04	1.1E-05	2.8E-04	2.9E-04
Z2-40	14	3	3	No COPCs	4.7E-06	4.7E-06	No COPCs	4.7E-06	4.7E-06
Z2-41	38	86	112	4.9E-06	4.0E-04	4.0E-04	3.1E-06	2.5E-04	2.5E-04
Z2-42	15	16	20	2.5E-06	9.7E-04	9.7E-04	2.5E-06	6.9E-04	6.9E-04

Table 2.5. Summary of the number of locations with data and carcinogenic risk calculations for soils, ETTP Zone 2, Oak Ridge, Tennessee (continued)

				Risk calculations (excluding ^{226}Ra and ^{232}Th)[d]					
		Number of locations with surface soil data[b]	Number of locations with subsurface soil data[c]	Surface soil[b]			Subsurface soil[c]		
Exposure unit[a]	EU size (acres)			Chemical risk	Radiological risk	Total risk (Chem + Rad)	Chemical risk	Radiological risk	Total risk (Chem + Rad)
Z2-44	16	4	4	3.9E-06	3.4E-06	7.3E-06	3.9E-06	3.4E-06	7.3E-06

Notes:

No COPCs = No contaminants of potential concern were identified (i.e., all contaminants with valid carcinogenic slope factors were eliminated from the COPC list during screening for this EU); thus, no risks are shown.

[a]Only EUs with soil data are shown on this table (EUs Z2-07, -34, and –43 currently do not have soil data available).

[b]Surface soil data include all data with a starting sample depth of <2 feet below ground surface (bgs).

[c]Subsurface soil data include all data with a starting sample depth of ≤ 10 feet bgs. (This includes all surface soil data plus data between 2 and 10 feet bgs).

[d]Risk calculations do not include ^{226}Ra or ^{232}Th.

ETTP = East Tennessee Technology Park.

Table 2.6. Percentage of total risk attributable to external exposure to radiation[a] for ETTP Zone 2 soils, Oak Ridge, Tennessee

Exposure unit	Surface soil[b]		Percent of total EU risk from external exposure to radiation	Subsurface soil[c]		Percent of total EU risk from external exposure to radiation
	Risk from external exposure to radiation	Total EU risk		Risk from external exposure to radiation	Total EU risk	
Z2-13	7.1E-04	7.3E-04	96.2	6.8E-04	7.0E-04	96.1
Z2-16	3.5E-04	3.7E-04	94.5	3.5E-04	3.7E-04	94.5
Z2-19	2.8E-03	2.9E-03	95.4	2.1E-03	2.2E-03	95.1
Z2-22	1.1E-04	1.2E-04	93.1	1.1E-04	1.2E-04	93.1
Z2-25	1.8E-03	1.9E-03	94.4	4.0E-04	4.3E-04	93.5
Z2-28	1.3E-04	1.4E-04	92.8	1.3E-04	1.4E-04	92.8
Z2-29	3.9E-05	1.3E-04	29.3	3.6E-05	1.3E-04	27.6
Z2-30	2.2E-04	2.5E-04	88.5	2.2E-04	2.5E-04	88.5
Z2-31	1.6E-04	1.8E-04	90.6	2.4E-05	2.7E-05	87.0
Z2-33	3.3E-04	3.4E-04	94.8	2.7E-04	2.8E-04	95.1
Z2-39	4.2E-04	4.6E-04	91.7	2.7E-04	2.9E-04	91.4
Z2-41	3.9E-04	4.0E-04	95.6	2.4E-04	2.5E-04	95.6
Z2-42	9.7E-04	9.7E-04	99.6	6.9E-04	6.9E-04	99.5

[a]Risks do not include contributions from ^{226}Ra and ^{232}Th.
[b]Surface soil = soil data with starting depths from 0 to 2 feet below ground surface (bgs).
[c]Subsurface soil = soil data with starting depths from 0 to 10 feet bgs.
ETTP = East Tennessee Technology Park.
EU = exposure unit.

Table 2.7. Remedial action objective and protection goal for ETTP Zone 2, Oak Ridge, Tennessee

Remediation issue	Protection goal
Future land use	Protect human health under an industrial land use to an excess cancer risk level at or below 1×10^{-4} and non-cancer risk levels at or below an HI of 1.
Groundwater resources	Protect groundwater to levels at or below MCLs.

ETTP = East Tennessee Technology Park.
HI = hazard index.
MCL = maximum contaminant level.

2.9 SUMMARY OF REMEDIAL ALTERNATIVES

Having defined the cleanup objective, a range of remediation alternatives was developed in the FFS to achieve these goals. In accordance with CERCLA [40 CFR 300.430(1)], the goal of the FFS was to develop and evaluate remedial alternatives that eliminate, reduce, or control risks to human health. The NCP defines the preferences below in developing alternatives:

- Use of treatment to address the principal site threats, wherever practical.

- Use of engineering controls (e.g., containment) for waste that poses a relatively low, long-term threat and for which treatment is not practical.

- Implementation of a combination of actions, as appropriate, to achieve protection of human health. For example, in appropriate site situations, treatment of principal threats is combined with engineering and institutional controls for residual wastes.

- Use of institutional controls to supplement engineering controls for short-and long-term management to prevent or limit exposures to hazardous substances.

- Selection of an innovative technology when the technology offers the potential for comparable or better treatment performance or implementability than other technologies, fewer adverse impacts than other technologies, or lower costs than demonstrated technologies for similar levels of performance.

Principal threat wastes are those contaminated materials considered highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Principal threat wastes at ETTP are primarily secondary sources, such as DNAPLs, and are not covered in this decision. The pits at the K-1070-C/D Burial Ground at one time could have contained principal threat wastes; however, the pit with the greatest risk of release, G-Pit, has already been removed. The remaining burial ground areas in Zone 2 were not used frequently for liquid disposal nor are they anticipated to contain high levels of toxic or mobile contamination. Treatment of principal threat waste is, therefore, not a basis of an alternative under this ROD.

A primary problem addressed in this ROD is exposure of a hypothetical industrial worker to soil with small, ongoing releases to underlying groundwater from these same soil or waste materials. Most of the soil with sufficient risk to require remediation is located near the surface (with a few notable exceptions). Application of a containment technology to the soil in isolated areas was not considered for surface contamination because the presence of lots of small caps in an industrial setting is not practical. Containment options also limit future surface use as the engineered controls would need to be maintained to be effective.

Removal is the only general response action (GRA) assigned to soils in the developed alternatives. However, there is the potential to remediate ETTP to varying degrees. This variation is reflected in a range of alternatives for soil from meeting a future industrial land use criteria in the top 10 feet to meeting industrial land use criteria in the top 2 feet. In both cases, soil causing a future unacceptable release to groundwater that could cause future exceedances of MCLs would be removed to the water table or to bedrock surface. The other variation considered was for K-1070-C/D, the Classified Burial Ground. In one alternative full excavation of the burial ground so that no access controls would be required for security is developed, while in another alternative only excavation to meet the RAOs is developed, leaving behind material that may require access controls for security but will not require any institutional controls in addition to those required throughout Zone 2 to restrict exposures to residual contamination.

Containment, however, may be cost-effective on larger areas of contamination such as a burial ground. The K-1070-C/D Classified Burial Ground is located on a topographic high, and groundwater flows radially from the area. A cap, with or without subsurface interceptors, can effectively isolate the waste material from water. However, K-1070-B is located adjacent to Mitchell Branch, and upgradient groundwater flows laterally through the waste. A cap alone would not isolate the waste material from groundwater, and upgradient drains may cause a recharge along Mitchell Branch, drawing water back into the burial ground. Containment for the K-1070-B Old Classified Burial Ground would not effectively isolate the waste. Therefore, an alternative that contains the K-1070-C/D Classified Burial Ground is developed, but for the alternatives where the K-1070-B Old Classified Burial Ground requires remediation, removal would be the only GRA considered. The K-1070-G Burial Ground is currently assumed to not be contaminated to levels that would require remediation for either worker protection or protection of groundwater. Due to the small size of this disposal area (less than 1 acre), it would be treated like a soil site, and any contamination detected above soil remediation levels would be removed, if needed.

Based on the above discussion, the following alternatives are developed in the FFS (DOE 2004a and b):

- Alternative 1 - No Action,
- Alternative 2 - Removal of Soil (10 feet) and Full K-l070-C/D Removal,
- Alternative 3 - Removal of Soil (10 feet) and Containment of K-1070-C/D,
- Alternative 4 - Removal of Soil (2 feet) and Containment of K-1070-C/D, and
- Alternative 5 - Removal of Soil (10 feet) and Partial K-1070-C/D Removal.

Soil actions to protect human health, regardless if the soil is associated with a specific FFA site, are part of this Zone 2 decision. In addition, each FFA site will be addressed by each alternative, even if the action is merely confirmatory sampling and/or institutional controls. Appendix A presents the list of the FFA characterization area sites located in Zone 2 that are addressed by this decision. The type of problem each site may represent is also presented in the table. Buildings located in Zone 2 that have been demolished under earlier removal action decisions have slabs and subsurface structures (basements) that are also being addressed by this decision. Their subsurface contamination falls under the FFA site titled "HTTP sitewide soil" that is also covered by this decision.

2.9.1 ALTERNATIVE 1 - NO ACTION

As required by the NCP, the no-action alternative provides a comparative baseline against which other alternatives can be evaluated. Under this alternative, DOE would take no remedial action and would eliminate all existing controls. All soil contamination, buried waste, slabs, and subsurface structures, such as basements, tanks, and pipelines, would be left in place with no engineering or institutional controls to reduce future exposure to humans or to mitigate releases to groundwater. Existing media monitoring and institutional controls would be discontinued, and site fencing and access controls would not be maintained.

2.9.2 ALTERNATIVE 2 - REMOVAL OF SOIL (10 FEET) AND FULL K-1070-C/D REMOVAL

The actions under this alternative are designed to protect a future industrial worker within ETTP Zone 2 with minimal restrictions and to control unacceptable releases to underlying groundwater as defined by future MCL exceedances as stated in the RAOs. Each of the problems is addressed by an action in this alternative. Figure 2.12 presents the locations anticipated for these actions to occur. Removal of 34,000 in situ cubic yards (cy) to 105,000 in situ cy of soil or subsurface structures (including slabs) is part of this alternative. The removal would achieve industrial remediation levels to a depth of 10 feet and any

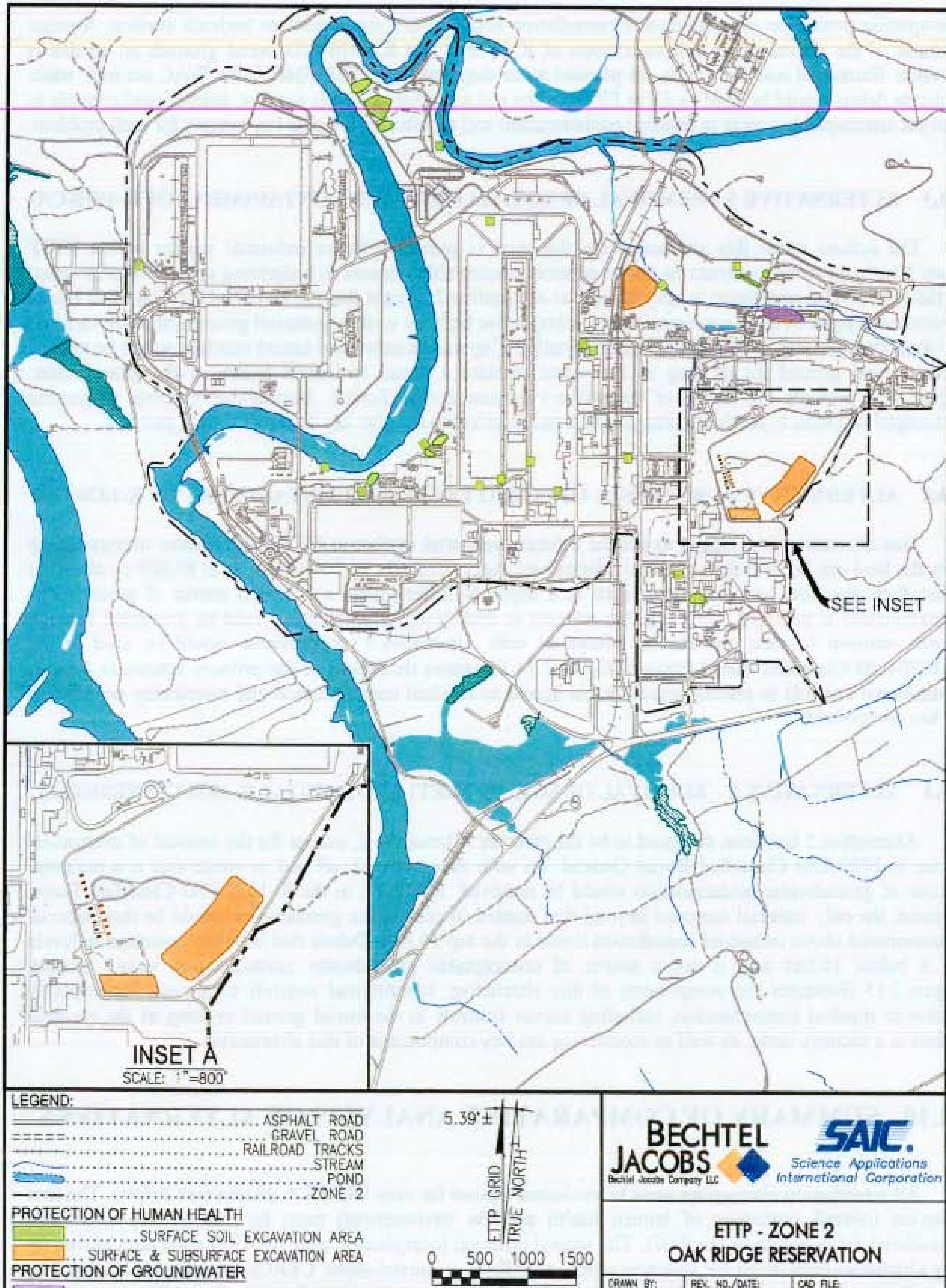

Fig. 2.12. Alternative 2 actions.

site-specific protection of groundwater remediation levels to the water table or bedrock surface. Another element of the alternative is full excavation of K-1070-B and K-1070-C/D burial grounds so no debris remains. Excavated soil and debris are planned to be disposed at the EMWMF, if the WAC are met, while concrete debris would be used as fill at ETTP, if the soil remediation levels are met. Institutional controls to prevent unacceptable access to residual contamination and monitoring are also key actions for each problem.

2.9.3 ALTERNATIVE 3 - REMOVAL OF SOIL (0 FEET) AND CONTAINMENT OF K-1070-C/D

The actions under this alternative are designed to protect a future industrial worker within ETTP Zone 2 with only a few restrictions and to control unacceptable releases to underlying groundwater as stated in the RAOs. This alternative is very similar to Alternative 2, except that the K-1070-C/D Classified Burial Ground is capped. A large cap covering the topographic high, as well as potential groundwater source areas (C-Area and the south pits area), would be installed. Cap maintenance and access controls would be needed at the burial ground for as long as the waste remains a threat to human health or the groundwater. Figure 2.13 presents the layout of the primary actions across Zone 2. Institutional controls to prevent unacceptable access to residual contamination and monitoring are also key actions for each problem.

2.9.4 ALTERNATIVE 4 – REMOVAL OF SOIL (2 FEET) AND CONTAINMENT OF K-1070-C/D

This alternative is designed to protect a future industrial worker at ETTP with greater restrictions on how the land can be used than previous alternatives. Approximately 33,000 in situ cy to 83,000 cy of soil or subsurface structures would be excavated to a depth of 2 feet unless a potential source of groundwater contamination is involved. Unacceptable releases to underlying groundwater would be prevented through source removal to meet the RAOs, except as with Alternative 3, containment would be used at the K-1070-C/D Classified Burial Ground. Figure 2.14 illustrates the layout of the primary actions in Zone 2. Institutional controls to prevent unacceptable access to residual contamination and monitoring continue to be key components.

2.9.5 ALTERNATIVE 5 – REMOVAL OF SOIL (10 FEET) AND PARTIAL K-1070-C/D REMOVAL

Alternative 5 has been designed to be the same as Alternative 2, except for the amount of excavation at the K-1070-C/D Classified Burial Ground. As with Alternative 2, all soil or waste that is a potential source of groundwater contamination would be removed. However, in the K-1070-C/D Classified Burial Ground, the only material removed beyond that needed to protect the groundwater would be that material contaminated above industrial remediation levels in the top 10 feet. Debris that is below remediation levels or is below 10 feet and is not a source of unacceptable groundwater contamination would remain. Figure 2.15 illustrates the components of this alternative. Institutional controls to prevent unacceptable access to residual contamination, including access controls at the burial ground as long as the residual debris is a security issue, as well as monitoring are key components of this alternative.

2.10 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

All remediation alternatives must be evaluated against the nine CERCLA criteria (see below). The first criterion (overall protection of human health and the environment) must be met by any alternative

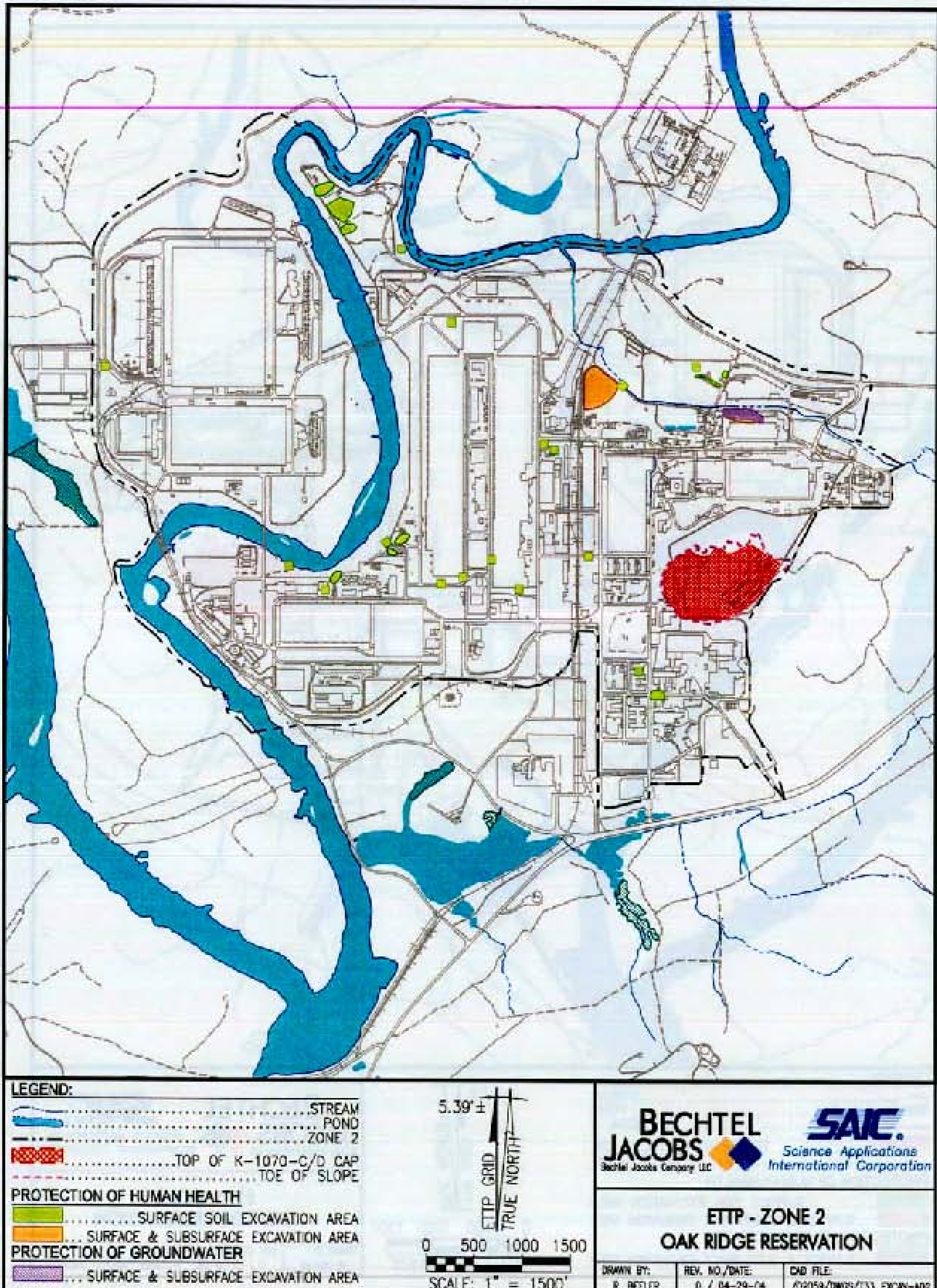

Fig. 2.13. Alternative 3 actions.

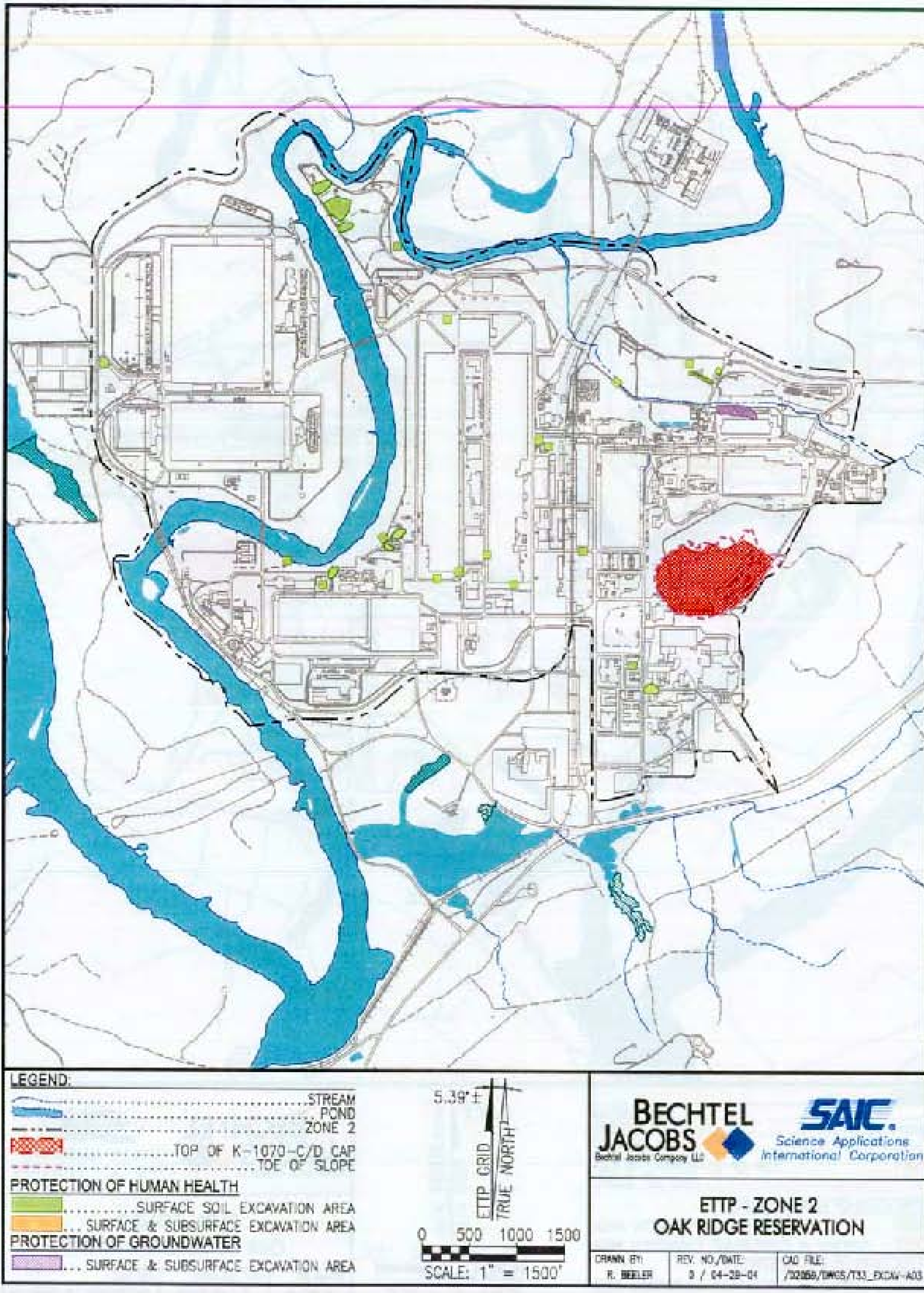

Fig. 2.14. Alternative 4 actions.

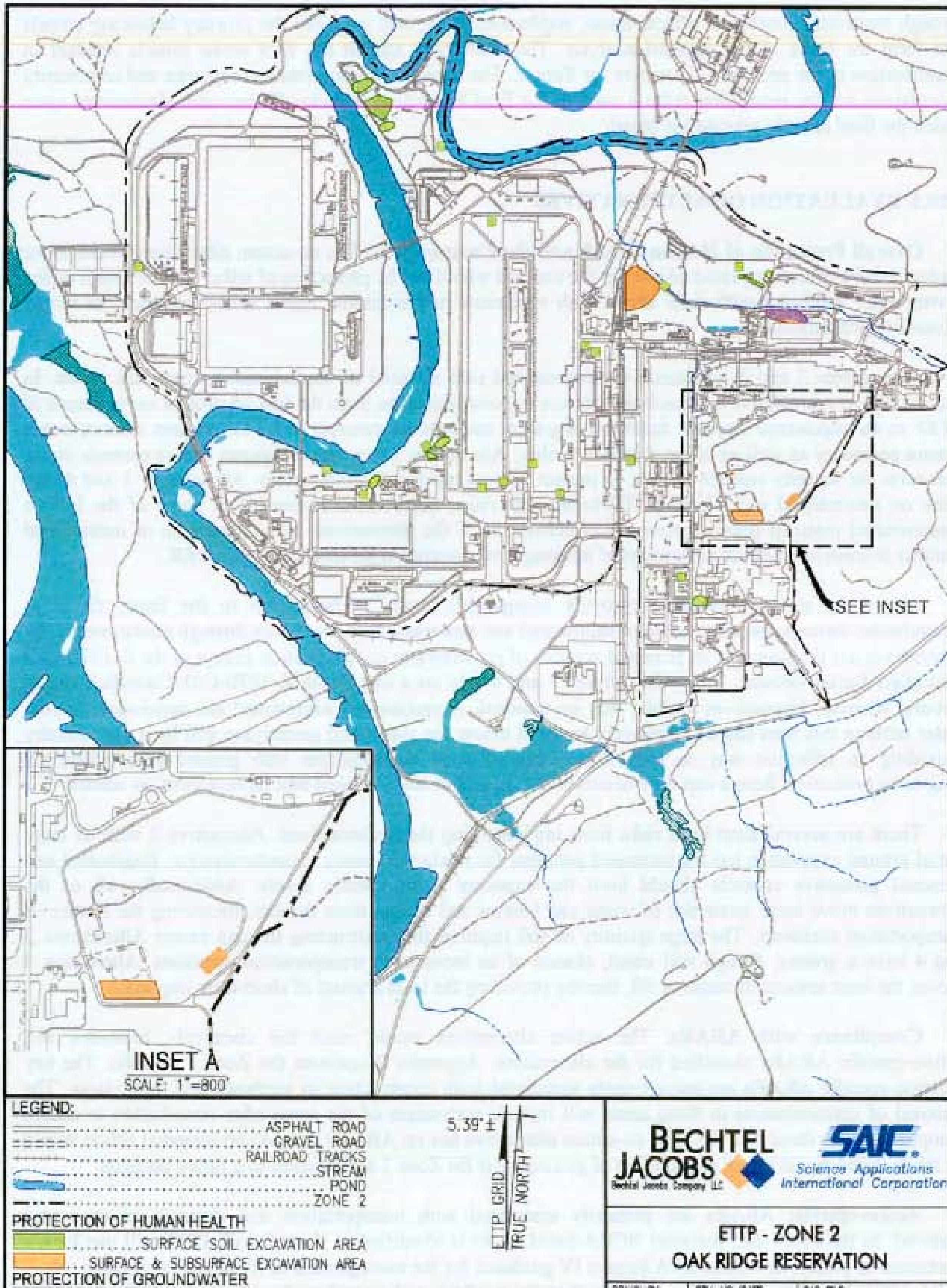

Fig. 2.15. Alternative 5 actions.

considered for selection in the ROD. The second criterion (compliance with) must also be met by any alternative considered for selection unless an ARAR is waived under CERCLA Section 121(d)(4). The next five criteria (long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost) are the primary balancing criteria that form the basis of the detailed analysis. The evaluation against the first seven criteria resulted in identification of the preferred alternative for Zone 2. The final two criteria (state acceptance and community acceptance) are the modifying criteria used in the final balancing of trade-offs between alternatives upon which the final remedy selection is based.

2.10.1 EVALUATION OF ALTERNATIVES

Overall Protection of Human Health and the Environment. The no-action alternative would prove inadequate for addressing residual risks at the site and would not be protective of either human health or the environment. Human health risks above both residential and industrial levels would continue, as would releases to groundwater.

Alternatives 2 and 5 emphasize excavation and safe disposal of contaminated waste and media. In general, this is a protective approach as it moves the contamination from the less controlled environment of ETTP to an engineered disposal facility. Long-term institutional controls at ETTP are less restrictive but remain necessary as well as at the disposal facility. Alternative 5 requires additional access controls in the near-term for security reasons but not to protect against residual contamination. Alternatives 3 and 4 rely more on institutional controls at ETTP to manage risks; however, the removal of some of the known contaminated material does improve the effectiveness of the alternatives. The application of institutional controls is considered effective because of the long-term governmental mission on the ORR.

All of the action alternatives provide comparable levels of protection to the future threat to groundwater through the removal of contaminated soil and waste burial areas or through containment. All alternatives are the same for all potential sources of groundwater contamination except at the K-1070-C/D Classified Burial Ground. Both Alternatives 3 and 4 rely on a cap at the K-1070-C/D Classified Burial Ground whereas Alternatives 2 and 5 rely on removal. A preliminary assessment has concluded that the water table in this area can be effectively lowered below the waste and underlying soil by a cap, thereby providing an effective way to stop future migration of contaminants into groundwater. However, long-term protection from a cap only occurs with aggressive maintenance and replacement, as needed.

There are several short-term risks from implementing these alternatives. Alternative 2 with its large burial ground excavation has the increased potential for worker exposure to contamination. Engineered and personal protective controls should limit the exposure to acceptable levels. Additionally, all of the alternatives move large quantities of waste and borrow soil to and from the site, increasing the chance of transportation accidents. The large quantity of soil required for constructing the cap means Alternatives 3 and 4 have a greater, though still small, chance of an increase in transportation accidents. Alternative 5 moves the least amount of waste or fill, thereby providing the least amount of short-term impacts.

Compliance with ARARs. The action alternatives would meet the chemical-, location-, and action-specific ARARs identified for the alternatives. Appendix B contains the Zone 2 ARARs. The key location-specific ARARs are requirements associated with construction in wetlands and floodplains. The removal of contamination in these areas will include restoration of the areas after remediation to ensure compliance with these ARARs. The no-action alternative has no ARARs because no remedial action would be taken. Final decisions on remediation of groundwater for Zone 2 are deferred to a future decision.

Action-specific ARARs are primarily associated with transportation and disposal of excavated material. In the event that potential RCRA-listed waste is identified in Zone 2 soil, DOE will use EPA's contained-in policy, as well as EPA Region IV guidance for the management of RCRA-contaminated media (EPA 1992) [see Appendix B for a further discussion of this policy and guidance], to make a contained-in determination for the soil. EPA Region 9 industrial PRGs will be used for making initial "no longer contains" determinations. If the soils are determined to contain listed wastes at concentrations in excess of these PRGs, further site-specific risk evaluation may be performed to establish site-specific, risk-based criteria. All ARARs, including those for the management of RCRA-listed waste, if appropriate, will be met.

Long-term Effectiveness. Alternative 1, the no-action alternative, would not be effective or permanent. Soil and buried waste left in place would present an unacceptable risk to a future industrial worker and would continue to leach to the groundwater. The ETTP currently has numerous ongoing surveillance and maintenance requirements and relies on access controls to control human health risk. Under the no-action alternative, these controls would no longer remain in place. The longer-lived radionuclides present in the soil and buried waste units would continue to pose an unacceptable risk to human health and the environment.

Alternatives 2 and 5 use excavation to remove most of the residual contamination at ETTP that is a threat to groundwater or a risk to future industrial users. However, both rely on institutional controls to effectively control against access to deeper contamination and to prevent residential use of ETTP. Additionally, institutional controls at the point of disposal are also needed as the waste would not be permanently destroyed or altered. Alternatives 2 and 5 essentially consolidate material requiring more aggressive institutional controls in Bear Creek Valley (at the EMWMF) at an engineered facility.

Alternatives 3 and 4 rely more heavily on institutional controls and containment (capping of the K-1070-C/D Classified Burial Ground) at ETTP to provide effectiveness and permanence. Capping and institutional controls can be effective if maintained. The cap would be designed to lower the water table below the waste effectively stopping continued migration from the waste. However, the effectiveness of the cap depends on long-term maintenance and periodic replacement. Institutional controls are considered effective on the ORR because of the long-term presence of the government. Alternative 3 consolidates some material in Bear Creek Valley but leaves an area at El IP needing more aggressive long-term controls. Alternative 2 provides the greatest opportunity for future development of ETTP, providing socioeconomic benefits. Alternatives 3 and 5 also provide significant socioeconomic benefits, but K-1070-C/D Classified Burial Ground will always be inaccessible under Alternative 3 and is only inaccessible under Alternative 5 for a short time (until security is no longer an issue). Alternative 4 could allow the land to be developed in the future, but the greater limitations on use would make the site less attractive.

Reduction of Toxicity, Mobility, or Volume Through Treatment. The action alternatives provide no reduction of toxicity, mobility, or volume through treatment. There is no benefit from treating the material since there is very little contamination present, but there are large volumes, and treatment would not be cost-effective. The heterogeneous nature of the buried material makes most treatment technologies ineffective or cost-prohibitive.

Short-term Effectiveness. Alternative 1 takes no remedial action, and, therefore, there are no short-term impacts on workers, the community, or the environment. Alternatives 2 through 5 have similar durations and types of impacts on the workers (standard construction risks), the community (significant truck traffic increase and risk of accidents), and the environment (minimal soil disturbance and dust generation). The larger burial ground excavation of Alternative 2 offers the most risk to workers from exposure. The burial ground excavation of Alternative 2 is nearly four times as great of an effort than the other alternatives. However, the potential for transportation accidents increases with the greater fill volume required to construct a cap that is part of Alternatives 3 and 4. Alternative 5 has the least amount of s short-term impacts as less waste is excavated than for Alternative 2, but the large cap fill volumes of

Alternatives 3 and 4 are not required. All of the impacts from the alternatives should be controllable to meet requirements and good engineering practices.

Implementability. Alternative 1, No Action, has no activities to implement and, as such, is the easiest to implement. While the scale of operations anticipated under all alternatives is extensive, the technical components of those operations would be implementable. The security issues associated with excavating the burial grounds increase their difficulty. Also, handling large pieces of debris and the potential to excavate unexpected waste increases the difficulty of excavating burial grounds. Excavation schedules could be impacted if alternate materials handling or disposal options must be found for unplanned waste. The coordination of disposal scheduling also adds to the difficulty of excavating burial grounds. None of these difficulties is insurmountable, but these issues cause Alternative 2 to be the most difficult to technically implement. The remaining alternatives are comparable for implementability issues. There are no unusual administrative issues associated with any of the alternatives.

Cost. The escalated capital cost of Alternative 2 is $105 million; the capital cost of Alternative 3 is $72.5 million; the capital cost of Alternative 4 is $60 million; and the capital cost of Alternative 5 is $62 million. These costs represent the lower end of the volume ranges, which are considered to be the most likely to occur. The annual O&M costs of Alternatives 3 and 4 are almost three times as great as that of Alternative 2 because of cap maintenance requirements. Alternative 5 O&M costs are in between due to short-term access controls at the K-1070-C/D Classified Burial Ground. These estimates have an accuracy of+50/-30% for the assumed scope. These costs represent the lower end of the volume ranges, which are considered the most likely volumes. The higher end of the volume ranges would raise the costs proportionally.

State Acceptance. The state of Tennessee supports the selection of Alternative 5 as the Zone 2 remedial action.

Community Acceptance. Many concerns over the eventual state of HTTP were raised by the public. Included were concerns that the selection of Alternative 5 could impede further development opportunities by leaving a burial ground in place. These concerns are addressed in Section 3, the Responsiveness Summary. DOE believes Alternative 5 provides the best balance of long-term effectiveness with short-term impacts.

2.10.2 NEPA VALUES

In accordance with DOE Secretarial Policy on NEPA (DOE 1994), DOE evaluations under CERCLA and associated documents incorporate NEPA values to the extent practicable. The evaluation of NEPA criteria was conducted as sub-elements of the CERCLA criteria. However, the key conclusions are reiterated here. Short-term impacts of all action alternatives on the human environment will include increased road traffic, increased noise, and increased employment opportunities. The negative short-term impacts are balanced with the long-term gains and are controlled to minimize impacts to the extent practicable. In the long-term, the local socioeconomic potential will increase in the area through future reindustrialization of the site. The environment will improve through the removal of waste material. Roane County would benefit from implementation of all of the alternatives as the potential to use El IP as an industrial facility improves. This potential is greatest with Alternatives 2, 3, and 5, although it still exists under Alternative 4.

Cumulative impacts will depend on the extent of other actions on the ORR and the development of future land use plans for the ORR. Extensive movement of waste or building materials, at the same time as the excavated material from Zone 2 from any of the four action alternatives is transported to the disposal l location, could have a significant cumulative impact on local roads and transportation. The cumulative requirement of borrow material needed for Alternatives 3 and 4 and from other projects could result in the need for future expansion of borrow areas. The cumulation of actions at ETTP, regardless of alternative, results in a site usable for future industrial use with controls to prevent access to any residual contamination. Fuel and borrow soil will be irretrievably and irreversibly used during the action.

2.11 PRINCIPAL THREAT WASTES

The NCR established an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(l)(iii)(A)]. Identifying principal threat waste combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic, or highly mobile, that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur.

Zone 2 of ETTP no longer contains relevant quantities of highly toxic or very mobile waste. The one area in Zone 2 that may have contained principal threat wastes was G-Pit in the K-1070-C/D Burial Ground. The excavation and ex situ treatment of G-Pit and its waste occurred under an earlier ROD (DOE 2000b).

2.12 SELECTED REMEDY

2.12.1 SUMMARY OF THE RATIONALE FOR THE SELECTED REMEDY

DOE, with the concurrence of EPA and TDEC, has determined that the preferred alternative presented in the proposed plan (DOE 2004c) is the most appropriate option for remediation in Zone 2 of ETTP. The preferred, and now selected, alternative is Alternative 5 from the FFS Addendum. This remedy protects human health and the environment, complies with ARARs, offers the best balance in satisfying the CERCLA evaluation criteria, and is cost-effective. This remedy uses permanent solutions, and although it does not use treatment to reduce toxicity, mobility, or volume, it offers the most comprehensive and permanent solution available for contaminants that cannot be destroyed.

The selected remedy meets the RAO and achieves the best mix of actions possible. The selection of this remedy is based on the comparative analysis presented in the proposed plan (DOE 2004c) and summarized in this ROD. Actual implementation will be performed in accordance with the yet to be approved RDR/RAWP.

Remedy summary. The ETTP Zone 2 remedy is summarized in Table 2.8 along with the performance objective. This table also summarizes the preference for treatment as a principal element of the remedy and indicates why the preference was not satisfied. LUCs, including institutional controls, are a key element of the action.

2.12.2 CONSTRUCTION ACTIVITIES

Soil removal for worker protection. Contaminated soil exceeding the worker protection remediation levels will be excavated up to a depth of 10 feet. Deeper soil will be institutionally controlled to prevent unacceptable access. All soil in Zone 2 will be institutionally controlled to prevent residential use.

For each EU, the sufficiency of data to either determine if action is required, or to determine where to excavate when remediation is necessary, will be determined. The details of this program will be developed after signature of the ROD. The sampling strategy developed for soils in Zone 1 will serve as the starting point for this strategy. The Zone 1 strategy will be modified to consider that all of Zone 2 is considered an impacted area and that there are non-soil media to be sampled (slabs, basement walls, and infrastructure). Additionally, any lesson learned from the Zone 1 sampling implementation will be incorporated into the Zone 2 strategy.

Table 2.8. Principal actions for the selected remedy, ETTP Zone 2, Oak Ridge, Tennessee

Waste type	Remedial action	Preference for treatment	Performance objective (protection goals)
Soil	Remove to average remediation levels met across an EU and maximum remediation levels met at any location to a depth of 10 feet. Remove to groundwater protection levels to water table or bedrock. Dispose in the EMWMF or other appropriate facility.	Removal preferred because of anticipated future land use and limited cost-effectiveness of treating radionuclides, the primary contaminants of concern.	Protect industrial worker and groundwater
Buried Waste	Remove K-1070-B debris, regardless of depth, and soil above maximum remediation levels (or lower if needed to meet average remediation levels across the EU) and above groundwater protection remediation levels. Remove K-1070-C/D soil and debris above average remediation levels met across an EU and maximum remediation levels met at any location to a depth of 10 feet. Remove waste or soil to groundwater protection levels to water table or bedrock. Dispose in the EMWMF or other appropriate facility.	Removal preferred because of anticipated future land use and limited long-term effectiveness of treating radionuclides and debris.	Protect industrial worker and groundwater
Subsurface structures	Remove or decontaminate to average remediation levels met across an EU and maximum remediation levels met at any location to a depth of 10 feet. Use concrete as fill at ETTP if below industrial remediation levels or dispose at the EMWMF or other appropriate facility.	Only removal is applicable to contamination fixed in concrete or other manmade structures.	Protect industrial worker

EMWMF = Environmental Management Waste Management Facility.
ETTP = East Tennessee Technology Park.
EU = exposure unit.

In general, in the EUs where no current data exist, the potential for the presence of an area of unacceptable contamination will be assessed through process knowledge. At a minimum, if no reasonable potential exists for unacceptable contamination, sufficient random samples to determine the risk across the EU and to determine if the average remediation levels have been exceeded will be collected. If there is process knowledge that unacceptable contamination may exist but uncertainty on its location, random sampling designed to locate a hot spot will be used. An area of 50-feet radius is selected as the size below which insufficient exposure duration exists to cause an unacceptable risk for the greatest soil contamination levels found anywhere in Zone 2. Areas of potential or known contamination with minimal available data will be targeted with biased sampling to assess if maximum remediation levels have been exceeded. Based on results of systematic and biased sampling in the EUs, if no maximum or average remediation levels are exceeded and if the risk is below 10^{-4} (without radium and thorium), no further action will be needed.

In EUs where data exist but there is currently no indication that remediation is necessary, the sufficiency of the data to support a comparison to maximum remediation levels (especially around known or suspected sources or releases - FFA sites), to support a comparison to average remediation levels across the EU, and to support the EU risk assessment will be made. Additional data may need to be collected to support a decision that no further action is required.

In EUs where data exist that suggest remediation is necessary, again the sufficiency of that data to support a remedial action will be assessed. In instances where existing data show only average remediation levels are exceeded, the representativeness of the data to EU average conditions will be determined and the data may need to be supplemented with additional random samples. If there is a source or potential release that is not characterized, additional biased data may be needed. This is particularly true for listed FFA sites. Remediation will only occur if the average, maximum, or cumulative risk remediation levels are exceeded.

In EUs with existing maximum remediation level exceedances, remediation is required. In these cases, the sufficiency of the data to support an excavation activity will be assessed and the data supplemented if necessary. If there are other areas of the EU not affected by the excavation activity, the adequacy of the data for determining if more excavation is required would also need to be assessed. Confirmation sampling after excavation will be collected and will factor in the average remediation level comparisons and the risk calculations to determine if other areas in the EU require excavation. The most current EPA risk guidance available at the time the calculations are performed will be used.

Soil will be excavated using standard equipment over a period of 3 to 4 years, primarily dictated by the schedule of D&D activities. Utilities are most likely to be inactive at the time, and any inactive utilities encountered will be excavated along with the soil, if in the way. All excavated material will be sent to the EMWMF for disposal as long as the WAC is met. Confirmation sampling, laboratory or field analyses, and/or a radiological survey will be conducted to appropriately demonstrate that residual concentrations are below the maximum remediation levels. Upon completion, the hole will be filled or graded. The excavation area will be contoured to match the surrounding topography and provide positive drainage and vegetated, or otherwise protected, from erosion. Either soil or concrete below remediation levels can be used as fill, but a soil layer will be placed on the surface. Work is anticipated to be completed by the end of FY 2008 as discussed in the Oak Ridge Accelerated Cleanup Plan Agreement of June 2002.

To integrate the sampling and remedial action activities with currently planned building D& D activities, an overall ETTP remediation strategy has been developed. Work will be conducted at an EU level. Buildings will first be demolished, then the EU characterized. If remedial action is required, it will occur after the characterization. The exception occurs in EUs where the building demolition activity will take until FY 2008 and there is insufficient time between the end of demolition and the end of the closure period to conduct the characterization and remediation. In these EUs, the EU soil and slabs (along with any subsurface infrastructure) may be characterized before building demolition begins. It will be necessary to enter the buildings to characterize beneath them. A preliminary decision on the need for remediation will be made based on the collected data. Then, if the remedial action location in the EU is beneath the building, the building will first be demolished, then remedial action will occur. (If the action is outside the building footprint, remedial action can occur concurrent with demolition.) This action will be followed by confirmation sampling, both to determine if sufficient action occurred and to confirm that the post-demolition soil/slab conditions are the same (or better) than determined before demolition. The final decision on protectiveness for EU residual contamination would then be made. For the purposes of the FFS alternative development, existing data were used to determine soil volumes for excavation. A lower bound to a volume range was developed using just the data results. An upper bound to the volume range was developed by adding in other suspect areas with limited data but process knowledge suggesting a release may have occurred. The volume of soil anticipated to require excavation to protect an industrial worker is estimated between 27,000 and 74,000 in situ cy. Figure 2.14 showed the areas of excavation for the lower estimate.

Soil removal to protect groundwater. Soil that is a potential threat for future groundwater contamination will be removed. This could be soil that would cause a future exceedance of MCLs, residential risk-based levels for ^{239}Pu and ^{237}Np, or be a threat to future human health or the environment. Appendix C illustrates the process that will be used to determine what soil may require excavation for MCLs or risk-based levels for ^{239}Pu and ^{237}Np. This process was applied to soils in the K-1420 Facility Area, the K-1401 Acid Line, and around the K-1070-C/D Classified Burial Ground. Only soil in the K-1420 Facility Area was above site-specific remediation levels for the protection of groundwater to MCLs. The volume has been estimated at roughly 16,000 in situ cy and almost directly overlays the volume assumed to be excavated to protect the industrial worker.

To appropriately determine which areas require excavation, some additional biased sampling near potential sources will be conducted. This effort will be conducted prior to or during design. If any areas are found requiring excavation, the effort will occur to the average water table, the bedrock surface, or to soil below the site-specific remediation levels, whichever is shallower. Any soil excavated with contamination levels below the remediation levels will be placed back in the excavation hole. Concrete below remediation levels generated from other remedial and removal actions at ETTP could also be placed in the excavation hole (see above discussion).

Burial grounds. The selected alternative includes excavation of the burial grounds with contamination that causes an unacceptable risk to workers or could cause a future release to groundwater. The K-1070-G Burial Ground is not thought to be either a threat to future workers or to the groundwater. The K-1070-B Old Classified Burial Ground is not thought to be a threat to groundwater but is considered a threat to industrial workers. Areas of the K-1070-C/D Classified Burial Ground are potentially both a threat to groundwater and a risk to industrial workers. The actual boundaries of these areas contributing to unacceptable risk need to be confirmed during sampling.

All of the debris in the K-1070-B Old Classified Burial Ground would be excavated. Specifically, all classified or subsidable pieces of debris and all debris above remediation levels will be removed so no special access controls or future construction limitations will be required at the burial ground. The burial ground is considered small enough to completely excavate the debris, regardless of depth, to minimize access controls needed for security in the area. A volume of 19,000 in situ cy is assumed to require excavation and disposal. This volume could change after sampling or other characterization efforts, including some effort to locate the extent of debris.

The excavation of the K-1070-B Old Classified Burial Ground will require consideration of the potential for excavation of gas cylinders and large pieces of equipment. The cylinders require special handling and disposal while the large equipment may require size reduction to meet the WAC at the EMWMF. Manual sorting and staging will be needed to separate these items from other excavated material that can be placed directly in a dump truck or pile for transportation to the EMWMF. A size reduction facility is contemplated but will only be constructed if needed. A variance to the physical WAC will also be evaluated during implementation, if needed.

Care will be taken during the excavation of the K-1070-B Old Classified Burial Ground to limit visual access to the waste. The trucks will need to be escorted to the EMWMF for security reasons.

The excavation action of the K-1070-C/D Classified Burial Ground is different than for K-1070-B. Based on the data and source information presented in the approved RI (DOE 1995), it appears that up to two additional pits in the south pits area may require excavation. The major source of groundwater contamination in the area (G-Pit) has already been removed. Some of the pits may contain waste or soil that is an unacceptable risk to a future industrial user, and a secondary source of groundwater contamination may be present. Sampling of the pits is needed to confirm if any, and how many, pits may require excavation. The range of volumes is currently assumed to be two pits (200 in situ cy) to all pits (1000 in situ cy).

There is unknown contamination in the C-Area. No sampling within the disposal area has occurred. Soil sampling along the southern side of the area suggests that some VOCs may have been released from the area. The volumes of material that may require excavation in the C-Area vary from 4000 to 13,000 in situ cy. These volumes are merely based on differing percentages of the area and are very uncertain. A carefully planned sampling effort is required in this area. During excavation of the C-Area, small debris is expected to be encountered but no large debris. If any debris is found above the EMWMF physical WAC limits, it can be size reduced at the K-l070-B facility.

The D Trenches are likely to be minimally contaminated for two key reasons. First, only solid material was placed in these trenches, and surrounding soil and groundwater data support the conclusion that releases have not occurred in the area. Many of the records indicate that material placed was not contaminated. Second, a soil cover of at least 2.5 feet has been placed over the area, and most of one of the trenches was never used and was backfilled with clean soil. There is a possibility that contamination in the top 10 feet could be detected that would be a threat to industrial workers. The RI data (DOE 1995) suggest that the soil near the concrete pad is contaminated. However, the contamination is likely to only be detected in small areas. A range of volumes of 2000 to 5000 in situ cy is possible with 2000 cy being the likely condition.

Very large pieces of equipment were disposed in the trenches. It is possible that one could be encountered during excavation efforts in the top 10 feet. It is possible that some cutting of equipment may be needed to remove a portion that is above remediation levels in the top 10 feet, but the effort is thought to be small. It is more likely that any encountered large equipment contamination is below remediation levels.

Once excavation from any of the K-1070-C/D Classified Burial Ground areas is complete, concrete debris from slab removal or from building demolition activities will be brought on-site and used as backfill, if available. After filling, the surface will be revegetated.

Slabs and subsurface structures. The primary elements are building slabs, building basements/ pits/pipelines, and underground tanks.

Slabs. Between 6000 and 25,000 cy of slabs are anticipated to be removed, either because of contamination in the concrete or asphalt, or because of contamination in the soil underneath the slab. Protection of workers is the only rationale for slab removal. Limited mass and leachability of contamination in slabs causes them to not present a future groundwater threat.

Concrete slabs identified for removal have been estimated to be an average of 1 foot in depth. In cases where the soil underneath the slab is not anticipated to be contaminated and where the slab contamination is isolated, slab decontamination may occur instead of slab removal, if less expensive. This would minimize the remediation effort and waste-handling needs. However, where much of the slab is contaminated, slab removal may be the most efficient. If needed, a crusher would be used to reduce the size of the concrete to less than 2.5-in. diameter so the soil remediation levels could be applied. It is assumed that most of the concrete will be left in excavation areas or basements at ETTP, either in a crushed form that meets the soil remediation levels or in a slab form when surficially below risk-based levels. Generally, larger pieces of concrete would be placed at the K-25 Site and readily excavatable pieces of concrete would be placed in other basements and excavations. In all cases, void spaces will be minimized to limit future subsidence, the concrete would be covered with soil and vegetated, and the area contoured to allow positive drainage. Staging of the concrete may be needed to coordinate disposal space availability.

Building basements/pits/pipelines. The contamination in basements, vaults, pipelines, and pits could be detected in the walls or floors of the structure. Contamination in walls and floors is only a threat to future workers if located above 10 feet bgs. Due to the low mass and low leachability of contamination in concrete, this contamination is not a future threat to groundwater. Likewise, due to the small size of pipelines, it is unlikely that much of the pipeline material itself is a future threat to industrial workers and groundwater. Material found in basements, pits, vaults, or pipelines could be a threat, but the volumes would be very low. Those threats will be removed once located during sampling activities. Any residual large access points or holes in the ground will be filled for the future safety of users of the site.

Discharge from the K-1401 and K-1420 building sumps is pumped to the Central Neutralization Facility (CNF) for treatment prior to discharge. CNF personnel monitor the daily flow rates of these sumps and collect semi-annual samples from the sump discharge for chemical analysis. Flow data collected by CNF for calendar years 2002 and 2003 were examined. The data indicate that the K-1401 sump pumps an average of 8.6 gallons per minute (gpm), and the K-1420 sump pumps at an average rate of 9.6 gpm. Total VOC concentrations from the K-1401 sump varied from 110 to 210 µg/L while total VOC concentrations from the K-1420 sump varied from 740 to 1120 µg/L. Flow and analytical data for the two building sumps were used . to estimate the mass of VOCs removed by each sump. The mass over 2 years is estimated at just over 16 lbs for the K-1401 sump and just over 60 lbs for the K-1420 sump.

Sumps will be kept operational until the basement has been decontaminated or demolished and a groundwater decision has been made. This is anticipated to occur in fiscal year (FY) 2007 or FY 2008. The sitewide project is evaluating the impact on groundwater contamination migration of turning off the sumps, and accommodations may be needed in the final groundwater remediation approach. The final groundwater remedy would be implemented by FY 2008, including any action, if needed, to replace the sump action.

The demolition or decontamination of basements and other smaller manmade subsurface structures will be handled similarly to slabs. If the contamination is isolated, decontamination methods may be used if less expensive than removal. If the contamination area is large, the structure will be demolished. These areas will be filled with concrete or soil to promote positive drainage and seeded to prevent erosion. Waste generated from decontamination efforts will be sent to the EMWMF for disposal while concrete demolition waste will be considered as fill at HTTP if soil remediation levels can be met. The volumes of subsurface basement and other subsurface structure waste that is anticipated to be generated vary from minimal (less than 100 cy) to over 4000 cy. This upper volume includes the K-1004-J vaults.

Underground storage tanks. There are seven USTs remaining at ETTP that vary from 500 gal to 6000 gal. These tanks do not require remediation unless the soil or tanks (including residual contents) exceed remediation levels. The limited information (process knowledge and some soil data) suggests that these tanks and residual soils do not pose a threat to future industrial users or groundwater. However, the uncertainty is recognized and a plan to sample and, if necessary, remove the tanks and surrounding soil is part of this alternative as a contingent action.

Waste disposal. All of the soil and burial ground material excavated is assumed to require disposal at the EMWMF. The exception would be sufficiently clean soil excavated merely to access deeper contaminated soil or buried material. This soil will be left at ETTP. All concrete waste below remediation levels is assumed to be left at ETTP. All waste material planned for disposal at the EMWMF will be characterized prior to remediation to determine if the WAC can be met. Waste volumes from soil and burial ground excavations anticipated for disposal at the EMWMF vary between 52,000 and 112,000 cy. This volume is an in situ volume.

Between 6,000 and 29,000 cy of concrete waste may be generated from activities in this ROD with up to 300,000 to 500,000 cy of concrete generated from other site remediation activities, including those activities documented in the Remaining Facilities, K-25/K-27, and Group 2 AMs, may be placed at ETTP if Zone 2 remediation levels are met. This volume estimate assumes that all major structures at ETTP are demolished. It is anticipated that the K-25 footprint will be the preferred concrete placement area. Concrete placed in this area would not undergo extra size reduction. Figure 2.16 illustrates this location and the location of other major buildings with basements or areas requiring fill that could be used for concrete placement. In these areas, and in future excavation areas requiring fill, any concrete placed will be size-reduced to be easily excavatable in the future. These areas include vaults at K-27 and basements at K-731, K-1004-A, B, C, K-1037, K-1401, K-1420, K-1210, and K-1210-A. Some staging of removed concrete may be needed because fill locations may not be available in time. The preference will be to stage concrete near the fill location. This staging will meet all ARARs. Concrete will be placed in such a way as to support positive drainage of surface water and to minimize subsidence. The concrete will be covered with sufficient soil to support a vegetative cover. Details of the concrete handling will be developed in post-ROD documents as the same method would apply to Zone 2 remediation concrete as well as concrete waste generated under D&D activities outside the scope of this ROD.

2.12.3 MAINTENANCE ACTIVITIES AND ENVIRONMENTAL MONITORING

The monitoring requirements of the selected alternative include monitoring of groundwater adjacent to potential sources of groundwater contamination, including the K-1070-C/D Burial Ground. This monitoring will occur until the Site-wide ROD takes over monitoring at ETTP. Maintenance of patrol roads and fences at the K-1070-C/D Burial Ground would occur in the short-term until there is no further security issue. No maintenance of engineered components is necessary for environmental protection.

The effectiveness of institutional controls will be evaluated annually and documented as part of the RER. Additionally, the need for security measures at the K-1070-C/D Burial Ground will be evaluated annually. These security controls will be removed as soon as no longer needed.

2.12.4 LAND USE CONTROLS

Areas within Zone 2 cannot support unrestricted use due to hazardous substances remaining in place after implementation of the selected remedy. However, industrial use is acceptable. The site risks that necessitate restricted uses are summarized in Section 2.7. Land use restrictions are required as part of this CERCLA action to control these risks and will be achieved through imposition of LUCs that limit the use and/or exposure to all of Zone 2. DOE is committed to implementing and maintaining LUCs, including institutional controls, to ensure that the selected remedy remains protective of human health. The LUCs may be modified in the future if new information reveals that they are no longer needed to assure protectiveness.

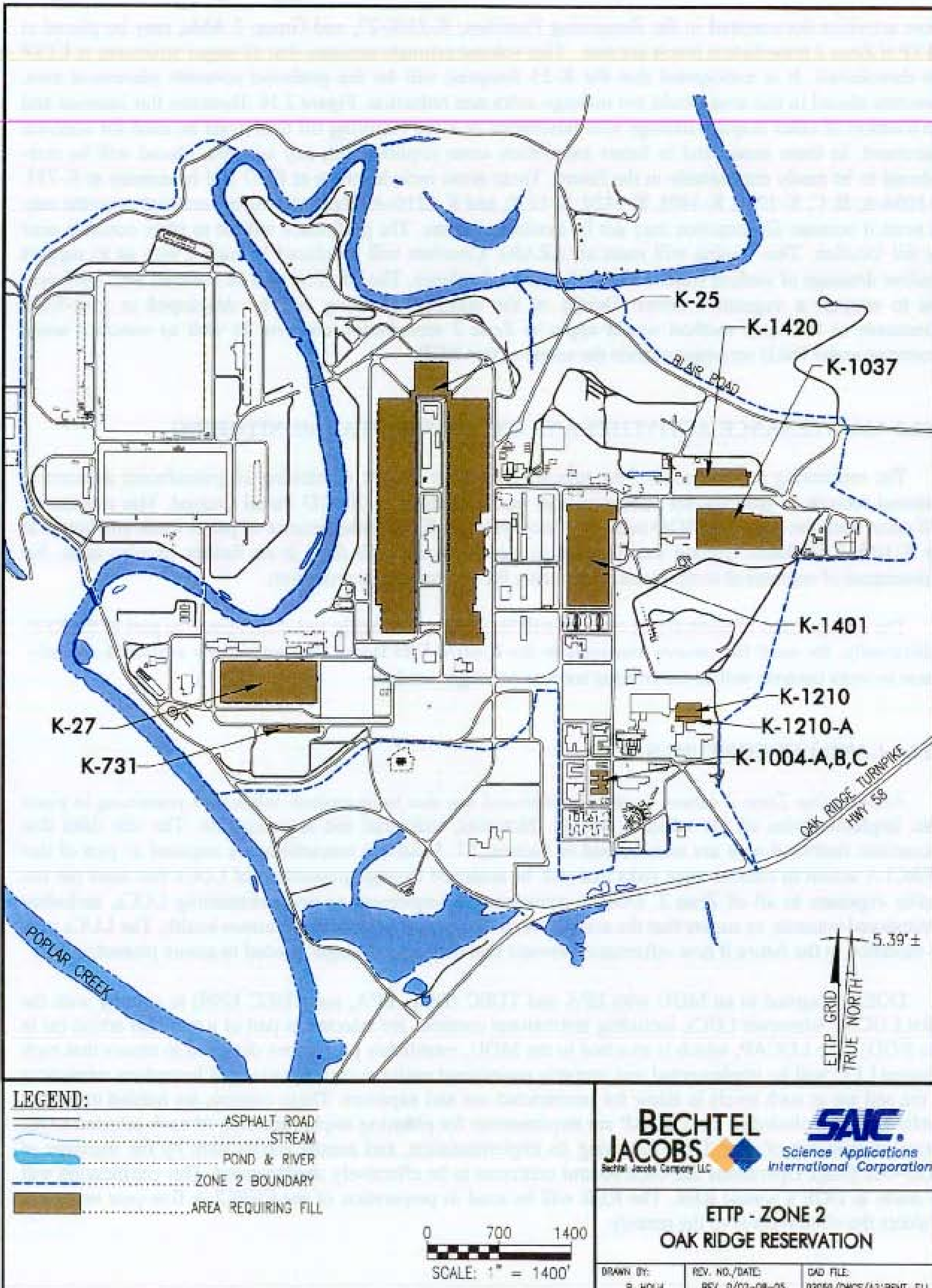

Fig. 2.16. Locations of major basements/areas requiring fill.

DOE has agreed in an MOU with EPA and TDEC (DOE, EPA, and TDEC 1999) to comply with the ORR LUCAP whenever LUCs, including institutional controls, are selected as part of a remedial action (as in this ROD). The LUCAP, which is attached to the MOU, establishes procedures designed to ensure that each selected LUC will be implemented and properly maintained until the concentrations of hazardous substances in the soil are at such levels to allow for unrestricted use and exposure. These controls are needed to protect public health. Included in the LUCAP are requirements for planning implementation of each selected LUC, annual monitoring of each LUC following its implementation, and annual certification by the manager of DOE-Oak Ridge Operations that each control continues to be effectively implemented. This certification will be made in DOE's annual RER. The RER will be used in preparation of the CERCLA five-year review to evaluate the effectiveness of the remedy.

In accordance with the LUCAP, upon the discovery of any activity that is determined to be inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs, DOE will notify EPA and TDEC as soon as practicable but no later than 30 days after discovery. This notification will provide all pertinent information as to the nature and extent of the activity and describe any measures implemented or to be implemented (including a timetable for future completion) to reduce or prevent human health or ecological impacts resulting from the activity.

Pursuant to the ORE. LUCAP, when a remedial action that includes LUCs has been selected, a LUCIP will be developed as a component of an enforceable post-ROD primary document or as a stand-alone primary document for regulatory approval. The anticipated schedule for the LUCIP is shown in Table 2.9. The LUCIP will specify LUC objectives for Zone 2, identify the controls and mechanisms required to achieve each objective, and describe the actions necessary to implement and maintain the LUCs. Upon regulatory approval, the Zone 2 LUCIP will establish the LUC implementation and maintenance requirements enforceable under CERCLA and the FFA. DOE will not modify or terminate the LUCs or implementation actions, or modify land use, without prior approval by EPA and TDEC. DOE will obtain prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

Table 2.9. Schedule for Land Use Control Implementation Plan, ETTP Zone 2, Oak Ridge, Tennessee

Activity	Duration of activity (days)
DOE issues LUCIP (Dl version)	See footnote[a]
EPA and TDEC review Dl LUCIP	90
DOE responds to regulatory comments on the Dl LUCIP and prepares the D2 LUCIP	60
EPA and TDEC review and approve the D2 LUCIP	30

[a] The Dl LUCIP will be submitted concurrently with post-ROD primary documents.
DOE = U. S. Department of Energy.
EPA = U. S. Environmental Protection Agency.
ETTP = East Tennessee Technology Park.
LUCIP = Land Use Control Implementation Plan
TDEC = Tennessee Department of Environment and Conservation.

Although DOE may later transfer these procedural responsibilities to another party by contract, property transfer agreement, property lease agreement, or through other means, DOE retains ultimate responsibility for the integrity and protectiveness of the remedy. Concurrent with any transfer of fee title from DOE to a transferee, information regarding the environmental use restrictions and controls will be communicated, in writing, to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property. In the event DOE determines to enter into any contract for the lease, sale, or transfer of any of the site, DOE will comply with the requirements of Section 120(h) of CERCLA and the ORR FFA (specifically, Section XLIII) regarding property transfer in effectuating that sale or transfer, including all notice requirements and provisions for the continued maintenance of LUCs that are no less restrictive than those selected in this ROD as part of the Zone 2 remedial action. Any lease agreement or property transfer deed will contain appropriate provisions to ensure that these restrictions continue to run with the land and are enforceable by DOE. Each transfer of fee title will include a CERCLA 120(h)(3) covenant that will have a description of the residual contamination on the property and the environmental use restrictions, expressly forbidding activities inconsistent with the performance measure goals and objectives. The environmental restrictions are included in a section of the CERCLA 120(h)(3) covenant that the United States is required to include in the deed for any property that has had hazardous substances stored for 1 year or more, known to have been released, or disposed of on the property. Each transfer deed will also contain a reservation of access to the property for DOE, EPA, and the state of Tennessee for purposes consistent with the FFA. During the time between the adoption of this ROD and deeding of the property, equivalent restrictions are being implemented by lease terms, which are no less restrictive than the use restrictions and controls described above, in this ROD. These lease terms shall remain in place until the property is transferred by deed, at which time they will be superseded by the institutional controls described in this ROD.

The Zone 2 ROD establishes industrial as the land use for Zone 2 to a depth of 10 feet (Section 2.6). The future Site-wide ROD would establish any necessary LUCs for groundwater, surface water, and/or sediment. To implement restrictions that prohibit residential or agricultural use of this area under the Zone 2 ROD and to restrict access to this area until that end use has been achieved, seven LUCs will be implemented based on the following LUC objectives:

- control land use to prevent exposure to contamination by controlling excavations or soil penetrations below 10 feet and prevent uses of the land involving exposures to human receptors greater than those from industrial use. Significant accumulations of material with residual contamination above unrestricted use levels will also be monitored and controlled. This will avoid accumulation of contamination placed in an area not currently designated for disposal that could reestablish a risk to a future industrial user;

- prohibit the development and use of property for residential housing, elementary or secondary schools, childcare facilities, children's playground, other prohibited commercial uses, or agricultural use;

- maintain the integrity of any existing or future monitoring systems until the HTTP Site-wide remedial action is implemented; and

- maintain the integrity of access controls at the K-1070-C/D Classified Burial Ground for as long as the residual debris is a security issue.

Until remediation is complete and the land use is achieved, reliance will be primarily on property record and zoning notices, the excavation/penetration permit program, access controls, and surveillance patrols. Once remediation is complete, property record restrictions, property record and other public notices, zoning notices, excavation permits, and less intensive surveillance patrols and fences for the short-term at the K-1070-C/D Classified Burial Ground will be used. Table 2.10 summarizes these controls, their duration, and how they are implemented.

All of the controls, except some of the short-term access controls, signs, and surveillances, will be applied to all areas of Zone 2 containing contamination above acceptable residential risk-based levels. The boundaries for LUCs are the same as the boundaries of the Zone 2 area, as shown on Fig. 2.2. However, following remedial action, the risks to a future resident from external exposure, direct contact, and incidental ingestion within each EU will be assessed with the data collected. If no unacceptable risk is found, the LUC boundaries will be modified and maps of residual contamination resubmitted to local officials, EPA, and TDEC.

DOE is responsible for implementing monitoring, maintaining, reporting on, and enforcing the LUCs selected in this ROD in accordance with the requirements in the LUCIP approved for ETTP Zone 2. DOE will provide notice to EPA and TDEC at least 6 months prior to any transfer or sale of land at ETTP so that EPA and TDEC can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for DOE to notify EPA and TDEC at least 6 months prior to any transfer or sale, then DOE will notify EPA and TDEC as soon as possible, but no later than 60 days, prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, the DOE further agrees to provide EPA and TDEC with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of the executed deed or transfer assembly to EPA and TDEC.

Table 2.10. Land use controls for ETTP Zone 2, Oak Ridge, Tennessee

Type of control	Purposes of control	Duration	Implementation	Affected areas[a]
1. Property Record Restrictions[b]	Restrict use of property by limiting penetrations deeper than 10 feet bgs and all uses involving exposures to human receptors greater than industrial use exposures.	Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.	Drafted and implemented by DOE upon completion of all remediation activities or transfer of affected areas. Recorded by DOE in accordance with state law at County Register of Deeds office.	Throughout all of Zone 2
2. Property Record and Other Notices[c]	Provide information to the public about the existence and location of contaminated areas and limitations on their use.	Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.	Notice recorded by DOE EM in accordance with state law at County Register of Deeds office: (1) as soon as practicable after signing of the ROD but no later than 90 days after approval of the LUCIP, (2) upon transfer of affected areas, and (3) other means of notices as specified in the LUCIP upon completion of all remedial actions. This notice will be replaced with the DOE land notation after completion of remediation.	Throughout all of Zone 2
3. Zoning Notices[d]	Provide notice to city and county about the existence and location of waste disposal and residual contamination areas and limitations on their use for zoning/planning purposes.	Until the concentrations of hazardous substances are at such levels to allow for unrestricted use and exposure.	Initial Zoning Notice (same as Property Record Notice) filed with City and County Planning Commissions as soon as practicable after signing of the ROD but no later than 90 days after approval of the LUCIP; final Zoning Notice and survey plat filed with City and County Planning Commissions upon completion of all remedial actions.	Throughout all of Zone 2
4. Excavation/ Penetration Permit Program[e]	Provide notice to worker/developer (i.e., permit requestor) on extent of contamination and prohibit or limit excavation/penetration activity.	As long as property remains under DOE control, including transferred property remaining subject to excavation/penetration permit program.	Implemented by DOE and its contractors. Initiated by permit request. Provide permits program with contamination information as soon as practicable after signing of the ROD, and update information regularly while remediation proceeds.	All areas where hazardous substances are left in the subsurface below 10 feet or where hazardous substances may be present but have not been detected because of the limits on characterization performed.
5. Access Controls[f] (e.g., fences, gates, and portals)	Control and restrict access to workers and the public to prevent unauthorized uses.	Until remediation is complete or until security is no longer an issue at K-1070-C/D.	Controls maintained by DOE.	Specific locations will, if necessary, be determined by each remediation project in the near-term. At K-1070-C/D until security is no longer an issue.
6. Signs[g]	Provide notice or warning to prevent unauthorized access.	Until the concentrations of hazardous substances left beneath 10 feet allow for industrial use and for K-1070-C/D until security is no longer and issue.	Signage maintained by DOE.	At select locations throughout Zone 2. At K-1070-C/D until security is no longer an issue.
7. Surveillance Patrols	Control and monitor access by workers/public.	Until remediation is complete or until security is no longer an issue at K-1070-C/D.	Established and maintained by DOE.	Patrol of selected areas throughout Zone 2, as necessary until remediation is complete. Then at K-1070-C/D until security is no longer an issue.

04-059(E)/040405

Table 2.10. Land use controls for ETTP Zone 2, Oak Ridge, Tennessee (continued)

[a]Affected areas – Specific locations identified in the Zone 2 LUCIP as part of a remedial design report/remedial action work plan. .

[b]Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of DOE and its predecessor agencies.

[c]Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination/waste disposal areas on the property.

[d]Zoning Notices – Includes information on the location of waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.

[e]Excavation/Penetration Permit Program – Refers to the internal DOE/DOE contractor administrative program(s) that require the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.

[f]Access Controls – Physical barriers or restrictions to entry.

[g]Signs – Posted command, warning, or direction.

DOE = U. S. Department of Energy.

ETTP = East Tennessee Technology Park.

2.12.5 COST ESTIMATE FOR THE SELECTED REMEDY

The cost estimate for the selected remedy is presented in Table 2.11. The total escalated capital cost is $62 million; however, if other areas are shown to require remediation, the overall volume of material removed may increase and a proportionate increase to the capital cost of this remedy would occur. The O&M costs include groundwater monitoring until the sitewide decision begins its performance monitoring program, institutional controls (maintenance of a permit program for deep excavation or penetration), and patrols in the short-term until there are no more security concerns. On the average, these O&M costs would be $178,000 annually.

Table 2.11. Cost summary table for ETTP Zone 2, Oak Ridge, Tennessee

Activity	Unescalated	Escalated
Regulatory Documents	$1,096,000	$1,129,000
Design	$1,889,000	$1,945,000
Predesign Sampling	$1,640,000	$1,690,000
Groundwater Eng. Study	$495,000	$510,000
Subtotal Indirect Costs	**$5,120,000**	**$5,274,000**
Project support/mgt	$9,083,000	$9,957,000
General Conditions	$11,512,000	$12,619,000
Soil Excavation/Backfill	$10,163,000	$11,141,000
Burial Ground Exc./Backfill	$6,133.000	$6,722,000
Subsurface structures	$7,086,000	$7,767,000
Waste disposal	$7,141,000	$7.828,000
Land use controls	$304,000	$333,000
Subtotal Direct Costs	**$51,423,000**	**$56,367,000**
CAPITAL COSTS	**$56,544,000**	**$61,642,000**
Groundwater monitor (5 years)	$256,000	$434,000
Burial ground control (27 years)	$932,000	$1,583,000
Land use controls (27 years)	$1,639,000	$2,785,000
O&M costs through year 30	**$2,827,000**	**$4,802,000**
ANNUAL AVERAGE O&M	**$104,000**	**$178,000**

O&M = operation and maintenance.

The information in the cost estimate summary table is generated from the estimate produced during the development of the proposed plan. The cost estimates were based on the best available information at the time of estimate regarding the anticipated scope of the selected remedy. Decreases in productivity factors were applied to soil (25%) and burial ground (40%) excavations to account for difficulties associated with working in radiologically contaminated areas and in secure areas, respectively. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the selected remedy, as well as if the security posture changes. The costs represent the most likely remediation volumes (lower end of range). If other areas are remediated during implementation of the selected remedy, the overall volume of material removed may increase and a proportionate increase to the capital cost of this remedy would result. Final costs will depend on actual labor and material cost, actual site conditions, productivity, competitive market conditions, action sequencing, final scope, final engineering design, and other variables. This is an order-of-magnitude engineering cost estimate that is expected to be within +50% to -30% of the actual project cost. If, after this ROD is signed, it is anticipated that because of volume increases above the lower end of the volume range or for any other reason, the cost of this action is expected to exceed an amount 50% above the cost estimate specified above, that increase will be documented with appropriate public notice in accordance with Section 300.435(c)(2) of the NCP.

2.12.6 REMEDY IMPLEMENTATION

2.12.6.1 Sequencing and Milestones

The actual schedule of activities will depend on numerous factors, including funding, logistics, and availability of resources. The order in which activities occur is flexible. However, there is significant dependency on the completion of D& D activities in Zone 2. Although some of the burial ground removal activities can occur independently of D& D activities, most of the soil and subsurface structure excavation is highly dependent on completion of building demolition activities.

Figure 2.17 shows a tentative sequence of some key aspects of the alternative. All remedial actions included in this ROD are currently projected to be completed by the end of FY 2008. Pursuant to Section XXXVIII of the FFA, DOE shall take all necessary steps to obtain sufficient funding for activities required by this ROD. This is to be accomplished, as set forth in that section of the FFA, through consultation with EPA and TDEC and the submission of timely budget requests. However, the planned completion date is a planning date only and is not considered to be an enforceable element of the selected remedy. The enforceable milestones and non-enforceable milestones for performance of remedial actions for the sites covered in the ROD are set forth in Appendix E and Appendix J of the FFA, respectively. Any milestones, timetables, or deadlines for sites included in this ROD will be identified and established independent of this ROD, in accordance with the existing FFA protocols.

2.12.6.2 Performance Objectives

The selected remedy for Zone 2 was summarized earlier in Table 2.8. Each component action in the selected remedy contributes in some way to meeting the RAO for Zone 2. The role of each principal action in fulfilling the RAO and required performance of the principal actions are shown in Table 2.12.

2.12.6.3 Remediation Levels for Industrial Worker Protection

Remediation levels establish the permissible risk, concentration, or exposure level of contaminants at a site that must be achieved by the completed remedy. Remediation levels for remedial actions under CERCLA are developed principally using site-specific risk assessments and ARARs, but may also consider any of the nine CERCLA criteria specified in the NCP. All remedial actions at CERCLA sites must be protective of human health and the environment and comply with ARARs unless a waiver is justified and granted. ARARs are often the determining factor in establishing remediation levels at CERCLA sites. However, where ARARs are not available or are not sufficiently protective, site-specific risk assessments are used to develop remediation levels for (1) carcinogens at a level that represents an ELCR to an individual of between 10^{-4} and 10^{-6}, and (2) noncarcinogens such that the cumulative risks from exposure will not result in adverse effects to human populations, incorporating an adequate margin of safety.

During and/or at the end of remedy implementation, data are collected and analyzed to measure whether the remedy has attained the remediation levels in the ROD with an acceptable level of confidence. Documentation of remediation level attainment for Zone 2 will use statistical methods to provide a quantitative estimate of the probability that the residual risk or exposure in an area does not exceed the respective remediation level. Statistical methods also provide for specifying (controlling) the probability of making decision errors.

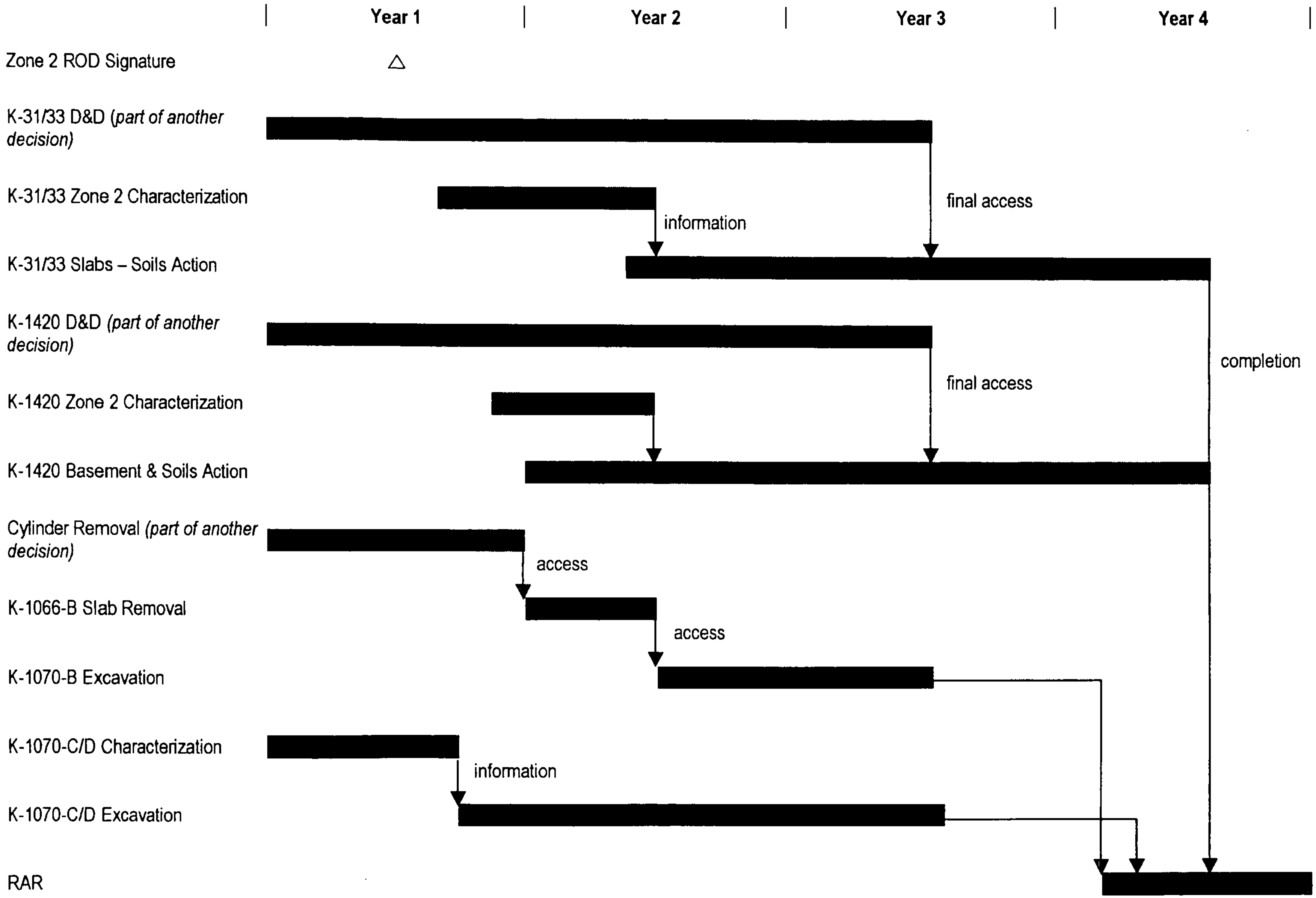

Fig. 2.17. Key sequencing activities.

04-059(E)/040405

Table 2.12. Performance measures for principal actions, ETTP Zone 2, Oak Ridge, Tennessee

Problem	Remedial action	Protection goal	Demonstration of effectiveness	Performance standard
Soil	Excavation and disposal in the EMWMF	Protect industrial worker and groundwater	Residual soil below worker protection remediation levels to a depth of 10 feet or groundwater protection levels to water table or bedrock	Average and maximum worker protection remediation levels and site-specific groundwater protection level
Buried waste	Excavation and disposal in the EMWMF (dewatering, manual sorting, and disassembly included)	Protect industrial worker and groundwater	Waste and residual soil below worker protection remediation levels to a depth of 10 feet or groundwater protection levels to water table or bedrock. At K-1070-B, all classified or subsidable waste removed, regardless of contamination.	Average and maximum worker protection remediation levels and site-specific groundwater protection level
Subsurface structures	Removal and disposal at ETTP or the EMWMF (disassembly and demolition included)	Protect industrial worker	Subsurface structures below remediation risk level to a depth of 10 feet	Average and maximum worker protection remediation levels

EMWMF = Environmental Management Waste Management Facility.
ETTP = East Tennessee Technology Park.

To protect an industrial receptor, both average remediation levels and maximum remediation levels for soil are established for specific EUs. The terms "average remediation level" and "maximum remediation level" are defined below:

- Average remediation level— a risk-based concentration not to be exceeded by the average (mean) concentration calculated for the EU. The risk basis would lie within EPA's acceptable risk range of 10^{-6} to 10^{-4} or below an HI of 1.

- Maximum remediation level— a risk-based concentration not to be exceeded for any particular location or small, contaminated area within the EU.

In addition, contaminated soil within an EU will be remediated so the residual risk (excluding radium and thorium) within that EU will be within the target risk range and an HI less than 1. In keeping with EPA's Risk Assessment Guidance, any HI exceeding 1 will be segregated into organ-specific His. If each organ-specific HI is less than 1, the contaminant concentrations will be determined to be protective of human health and will be acceptable. Organ-specific His and HQs exceeding 1 will be evaluated collectively by DOE, EPA, and TDEC, and risk-management decisions will be made based upon the site-specific conditions. The residual risk calculated for the EU would be based on appropriate data and statistical principles.

Derivation of radionuclide remediation levels to meet a specified risk limit consider both radioactive decay and ingrowth of daughter radionuclides over the exposure duration. The rate of radioactive decay is a fixed physical characteristic of each radionuclide and will be considered. Similarly, any ingrowth of radioactive decay products over time is included, particularly for cases where radioactive daughter products are more radiotoxic than the parent radionuclide, to ensure that the receptor would be protected to the selected risk limit.

Table 2.13 summarizes the remediation levels for the protection of human health in Zone 2 under the defined industrial risk scenario. The remediation levels are risk based. Risk is based on direct contact routes of exposure: incidental ingestion, inhalation of particulates and vapors, dermal contact, and external exposure. The industrial worker is assumed to have an exposure frequency of 2000 hours/year (8 hours/day for 250 days/year) and an exposure duration of 25 years.

Zone 2 is composed of 44 EUs (Fig. 2.10). The sizes of EUs vary from approximately 6 to 38 acres with most between 10 and 20 acres.

Average remediation levels were established for individual, primary COCs, using the following criteria:

- The risk within an EU for individual COCs will generally not exceed the average remediation levels of 10^{-5} to 10^{-4} ELCR or an HQ of approximately 1. Remediation levels for radium and thorium are not risk-based, but are set at an alternate concentration limit that is as low as reasonably achievable.

- The cumulative risk for all significant COCs combined will not exceed the average remediation levels of 10^{-4} ELCR, excluding radium and thorium, or an HI of 1.

For carcinogens, the maximum remediation level for any individual location within the EU has the same risk goal as the average remediation level but assumes an exposure frequency of 200 hours/year, one-tenth that of the average remediation level. For ^{226}Ra or ^{230}Th and ^{232}Th decay series, the average remediation levels are limited by the site-specific background concentrations. The maximum soil concentration for any individual location within an EU, therefore, may not exceed three times the average remediation level. For noncarcinogens, the maximum soil concentration may not exceed three times the average remediation level.

Table 2.13. Soil remediation levels for protection of human health, ETTP Zone 2, Oak Ridge, Tennessee

Receptor	Industrial worker
Exposure frequency and duration	2000 hours/year (i.e., 250 days/year) for 25 years
Nominal size and number of Eus	Forty four EUs ranging in size from 6 to 38 acres
Primary COCs	Significant carcinogenic COCs: ^{137}Cs, ^{226}Ra, ^{232}Th, ^{230}Th, ^{234}U, ^{235}U, ^{238}U, ^{237}Np, and PCBs Other potential contaminants: As and Hg
Secondary COCs	Cd, Cr, Cu, Fe, Ni, U, ^{60}Co, ^{90}Sr, and ^{99}Tc
Average remediation levels not to be exceeded for the EU	ELCR of 1 x 10^{-4} and an HI of 1 for all primary COCs combined, and an ELCR of 1 x 10^{-5} to 1 x 10^{-4} and an HQ of 1 for individual primary COCs Exception: mercury is set at an HQ of 1.9 to be consistent with Zone 1 Exception: 5 pCi/g above background for the ^{226}Ra or ^{230}Th decay series and the ^{232}Th decay series combined, averaged over each exposure area (similar to alternate concentration limits specified in 40 CFR 192 and DOE Order 5400.5)
Concentrations corresponding to average remediation level	See Table 2.14 for concentrations for primary COCs
Maximum remediation level not to be exceeded at individual locations	Ten times the average remediation level (equivalent to an industrial receptor exposure of 200 hours/year) for primary carcinogenic COCs except for radium and thorium decay series Three times the average remediation level for primary noncarcinogenic COCs Three times the average remediation level for the ^{226}Ra or ^{230}Th and ^{232}Th decay series (15 pCi/g above background for ^{226}Ra or ^{230}Th and ^{232}Th combined)

CFR - Code of Federal Regulations.
COC = contaminant of concern.
DOE = U. S. Department of Energy.
ELCR = excess lifetime cancer risk.
ETTP = East Tennessee Technology Park.
EU = exposure unit
HI = hazard index.
HQ = hazard quotient.
PCB = polychlorinated biphenyl.

Primary COCs are identified as those contaminants that would cause a risk above 1 x 10^{-5} or an HI above 1. Arsenic and mercury were added at EPA's request. Secondary COCs identified in the HHRA for Zone 2 include cadmium, chromium (evaluated as hexavalent chromium), copper, iron, nickel, uranium (as a metal), ^{60}Co, ^{90}Sr+D, and ^{99}Tc. Chromium, copper, iron, nickel, ^{60}Co, and ^{90}Sr+D were considered secondary because all detected soil concentrations are less than their associated risk level of 1 x 10^{-5} and/or

HI level of 1. Cadmium, uranium (as a metal), and 99Tc were considered secondary because they have very low frequencies of detected concentrations above their associated risk level of 10^{-5} and/or HI level of 1 and are commingled with other COCs that are shown on this table. A subset of samples (details to be specified in post-ROD sampling plan) collected during implementation of the Zone 2 actions will be analyzed for a more extensive list of potential contaminants (e.g., ^{99}Tc), including contaminants not listed as primary or secondary COCs. A risk assessment will be conducted to identify all COCs with significant contribution to risk. From those identified COCs, at the discretion of the Core Team, any contaminants determined to drive the need for remediation not already identified as primary COCs would be added to the primary COC list, and additional remediation levels would. be developed.

Soil remediation concentrations that correspond to the average remediation level for individual primary COCs are shown in Table 2.14. Uranium-238, the most prevalent contaminant, will be cleaned to an average concentration of 50 pCi/g in each EU. This average concentration corresponds to an incremental health risk of 3 x 10^{-5} ELCR, a risk that was set higher than the average risk goal of 1 x 10^{-5} for individual contaminants due to cost prohibitiveness considerations. Hot spots of ^{238}U will be remediated to levels below 500 pCi/g (maximum remediation concentration). Cost prohibitiveness and background levels were considered when selecting an average remediation level of 2 pCi/g of 137Cs, equivalent to an ELCR of 2 x 10^{-5}. Since the background level for 137Cs is 0.5 pCi/g (with an equivalent background risk of just under 1 x 10^{-5}), this suggested a remediation level that would be distinguishable above background for most modern gamma speciation field instrumentation. This remediation level would also reflect ^{137}Cs contamination that exists on the ETTP property as process/operations history versus background (global fallout) level, at a level that should be remediated.

The ^{226}Ra and ^{232}Th decay series are exceptions to the risk-based approach because they have alternate concentration-based remediation levels of 5 pCi/g above background (combined ^{226}Ra or ^{230}Th and ^{232}Th). This alternate concentration limit is commonly used by EPA and DOE and has been successfully implemented at numerous remediation sites throughout the United States containing radium and/or thorium as COCs (EPA 1998). For these radionuclides, setting a risk-based cleanup that attains a 1 x 10^{-4} risk-based goal (summation of risk for multiple COCs) is not attainable due to the risk associated with natural background concentrations, which alone exceed the desired risk goal of 1 x 10^{-4} ELCR. The mean background concentrations of ^{226}Ra or ^{230}Th and ^{232}Th in El IP soils are approximately 1 pCi/g each: The risk to an industrial receptor associated with these background levels is estimated at approximately 2 x 10^{-4} for ^{226}Ra and 9 x 10^{-5} for ^{232}Th. Alternate concentration limits, such as those specified in 40 CFR 192 and DOE Order 5400.5, can, therefore, be considered on a site-specific basis when setting appropriate cleanup standards for ^{226}Ra and ^{232}Th.

For ETTP Zone 2 soils, ^{226}Ra, ^{230}Th and ^{232}Th have been identified as COCs. In consideration of the site-specific distribution of these contaminants, the remediation level for ^{226}Ra and thorium (and their daughter products) has been set at 5 pCi/g above background, averaged over each EU (i.e., the combined concentrations of ^{226}Ra or ^{230}Th and ^{232}Th in soil may not exceed 5 pCi/g above their respective background concentrations, averaged over each EU). This value is set as low as reasonably achievable under the site-specific conditions. Because site-specific background concentrations of these radionuclides are at the top of the target risk range, residual concentrations of these radionuclides and their decay series will not be considered in the estimates of residual risk following completion of these actions.

In addition to the 5 pCi/g limit on average concentration of these radionuclides over each EU, no localized area of elevated contamination may exceed 15 pCi/g above background (combined ^{226}Ra or ^{230}Th and ^{232}Th). Since the opportunity for a receptor to be exposed to a small area of elevated contamination is much less than that for an entire EU, this limit on the maximum permissible concentration does not significantly impact the estimate of residual risk. As discussed in Office of Solid Waste and Emergency

Table 2.14. Soil remediation concentrations that correspond to the average remediation level for the industrial area, ETTP Zone 2, Oak Ridge Tennessee

Primary contaminants of concern[a]	Average individual remediation concentration[b]	Basis for average individual remediation concentration[c]	Risk corresponding to the individual average remediation concentration for the outdoor worker[d]	Residual average cumulative remediation goal[f]
Cesium-137 +D	2 pCi/g	Cost prohibitiveness consideration	2×10^{-5}	10^{-4} ELCR
Neptunium-237 +D	5 pCi/g	Risk limit	2.1×10^{-5}	
Uranium-234	700 pCi/g	Risk limit	1.2×10^{-5}	
Uranium-235 +D	8 pCi/g	Risk limit	2.2×10^{-5}	
Uranium-238 +D	50 pCi/g	Cost prohibitiveness consideration	3×10^{-5}	
PCB	10 mg/kg	Risk limit	1.8×10^{-5}	
Radium-226 +D	5 pCi/g	ARAR	2.2×10^{-4}	NA
Thorium-232 +D	5 pCi/g	ARAR	3.2×10^{-4}	
Thorium-230	5 pCi/g	ARAR	7.7×10^{-5}[g]	
Arsenic (As)[h]	300 mg/kg	EPA Region 4 policy[i]	NA[i]	10^{-4} ELCR
Mercury (Hg)[h]	600 mg/kg	Risk limit	HQ = 1.9	HI = 1

[a]Primary contaminants of concern are those identified in multiple samples above a 1×10^{-5} risk level or an HI of 1.

[b]The individual remediation concentration is the average remediation level for each target contaminant over an exposure unit (EU). These concentrations include background with the exceptions of radium-226+D, thorium-232+D, and thorium-230. The alternate concentration limit of 5 pCi/g above background for these isotopes is averaged over the EU and to the depth of remediation. Otherwise, the concentration limit is applied as in U. S. Department of Energy (DOE) Order 5400.5.

[c]The individual remediation concentration was based primarily on attaining a 10^{-5} industrial risk limit and maintaining consistency with the Zone 1 remediation concentrations.

[d]This column lists the risk values that correspond to the individual remediation concentrations for an outdoor worker.

[e]This column lists the risk values that correspond to the individual remediation concentrations for an indoor worker.

[f]The radium-226, thorium-232, and thorium-230 decay series are not included in the aggregate risk calculation for the EU. Rather, the remediation goal for these contaminants is similar to alternate concentration limits specified in 40 *Code of Federal Regulations* (*CFR*) 192 and/or DOE Order 5400.5, and is set as low as reasonably achievable.

[g]Risk for thorium-230 accounts for 1000 years of ingrowth of radium-226+D to be consistent with DOE Order 5400.5.

[h]Arsenic and mercury were not identified as COCs in the Human Health Risk Assessment but were included at the request of EPA.

[i]EPA Region 4 Policy Statement: "Arsenic is a naturally occurring mineral that is considered by EPA to be a systemic toxicant and a human carcinogen. However, there is considerable uncertainty concerning its ability to cause cancer at low exposure levels, especially the less soluble form that occurs in contaminated soil. The Superfund program of Region 4 regulates arsenic in soil as a systemic toxicant in deriving protective cleanup levels. As an additional precaution, EPA also requires soil cleanup levels to fall within the protective cancer risk range of 10^{-4} to 10^{-6} for the most sensitive likely receptor even though the calculated risk may be significantly over-protective."

ARAR = applicable or relevant and appropriate requirement.
D = radioactive decay daughter.
ELCR = excess lifetime cancer risk.
EPA = U. S. Environmental Protection Agency.
ETTP = East Tennessee Technology Park.
HI = hazard index.
HQ = hazard quotient.
NA = not applicable.
PCB = polychlorinated biphenyl.

Response (OSWER) Directive 9200.4-25, the value of 15 pCi/g above background was adopted in 40 CFR 192 as an indicator to locate subsurface soils containing elevated concentrations of radium or thorium. For ETTP Zone 2, the maximum concentration limit of 15 pCi/g above background serves a similar purpose, to help locate areas of elevated concentrations of these radionuclides in ETTP Zone 2 soils.

2.12.6.4 Remediation Levels for Protection of Groundwater

Soil that contains sufficiently high levels of soluble contaminants can be a source of contamination to groundwater. The horizon of soil considered is the soil in the unsaturated zone above and bedrock surface. The intent of soil cleanup is to remediate subsurface soil that poses a threat of causing continued or further spread of groundwater contamination. As a basis to identify the soil that poses an immediate threat to groundwater, soil will be remediated that contributes to a consistent long-term exceedance of MCLs. The point of exposure will be any place in the groundwater at HTTP. MCLs are assumed only for back-calculating soil and burial ground remediation levels and do not imply an anticipated future use or final groundwater goal. The groundwater will not have a remediation goal until the groundwater decision is made for ETTP.

The approach to determining required subsurface soil removal uses mathematical models [Seasonal Soil (Compartment) Model (SESOIL), Summers Model, and Analytical Transient 1-, 2-, 3-Dimensional (AT123D)] to estimate the amount of contaminant release from soil attenuation during migration, and the concentration that would occur in water withdrawn from a groundwater well conservatively positioned at the downgradient edge of the contaminated soil mass. The mass of contamination is considered instead of just the concentration. Contaminants that have the potential to exceed MCLs in the groundwater, as well as ^{239}Pu and ^{237}Np, will be evaluated. For ^{239}Pu and ^{237}Np, a residential PRO will be used in place of MCLs to assess the need for soil remediation. The calculation models and input parameters used for this evaluation are presented in Appendix C.

2.13 EXPECTED OUTCOMES

Performance standards and expected outcomes of the selected remedy are summarized in Table 2.12. Removal of contaminated subsurface structures along with removal of buried waste and contaminated soil will allow for industrial use down to 10 feet bgs of the entire Zone 2 area when remediation levels are achieved with the exception of the K-1070-C/D Classified Burial Ground, which will require access controls for some period of time due to security issues. The selected remedy should improve groundwater conditions through the removal of potential future sources of groundwater contamination.

2.14 STATUTORY DETERMINATIONS

Under CERCLA, Section 121, selected remedies must protect human health and the environment, comply with ARARs (unless a statutory waiver is justified and granted), be cost-effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that, as their principal element, use treatment that significantly and permanently reduces the volume, toxicity, or mobility of hazardous wastes. The following sections discuss how the selected remedy addresses those statutory requirements.

2.14.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy protects human health and the environment, primarily through removal of contamination from Zone 2 to levels protective of industrial workers and LUCs limiting the use of remediated areas to industrial activities. Additional work may be necessary for complete ecological protection, but significant risk reduction to terrestrial species will coincidentally occur through the removal activities. Additional human health protection is provided through LUCs in areas throughout Zone 2 and on the use of deep soils. No adverse long-term environmental impacts are anticipated. Any short-term impacts to the environment will be minimized or mitigated.

2.14.2 COMPLIANCE WITH ARARS

The selected remedy will meet the chemical-, location-, and action-specific ARARs identified for the alternative (see Appendix B of this ROD for Zone 2 ARARs and to-be-considered guidance). The key location-specific ARARs are requirements associated with construction in wetlands and floodplains. The removal of contamination in these areas will include restoration of the areas after remediation to ensure compliance with these ARARs.

2.14.3 COST-EFFECTIVENESS

The selected remedy is cost-effective because it meets the following definition: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" [40 CFR 300.430(f)(l)(ii)(D)]. The significantly greater cost of more aggressive remediation alternatives that would provide little additional risk reduction is not justified.

2.14.4 USE OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedy uses permanent solutions to the maximum extent practicable, and it represents the most comprehensive and permanent solution available for contaminants that otherwise cannot be destroyed. Removal of contamination is considered a permanent solution.

2.14.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

CERCLA, Section 121, establishes a preference for alternatives that use treatment to permanently reduce the toxicity, mobility, or volume of hazardous substances. The selected remedy does not satisfy CERCLA's statutory preference for treatment as a principal element of the remedy. However, the heterogeneous nature of the buried material makes most treatment technologies ineffective or cost-prohibitive. Currently, treatment technologies are either not available or not cost effective to reduce the toxicity, mobility, or volume of the COCs for Zone 2, which are primarily radionuclides. Therefore, treatment would not provide any greater reduction of risk and is determined not to be cost-effective.

2.14.6 FIVE-YEAR REVIEW REQUIREMENTS

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. DOE will include this five-year review as part of the RER, a primary document submitted for EPA and TDEC approval in accordance with requirements of the FFA for the ORR

2.15 DOCUMENTATION OF SIGNIFICANT CHANGES

There have been no significant changes to the selected remedy since the proposed plan was released. However, clarification about the anticipated final condition of HTTP is being provided. Activities to be conducted under this ROD are intended to be compatible with potential future use of the site for reindustrialization activities and/or historic preservation efforts. Closure activities at the site include the following:

- Remediation to industrial risk-based levels that would also be protective if the land were used for non-industrial purposes (other than residential or agricultural) including historical preservation.

- Placement of concrete on-site in an aesthetically pleasing manner (soil covered) that also supports future development. Future construction in the K-25 Building footprint is considered less likely. Concrete placed in the footprint may consist of larger sized pieces than elsewhere on the site due to the potential future use. If concrete is disposed outside this area, it will be size reduced to allow for future excavation, if necessary.

- Extra effort to avoid damaging important site infrastructure during remediation (main trunk lines or active lines to transferred facilities).

- Backfilling all basements and excavations with soil or concrete. This material will be compacted sufficiently to promote positive drainage. It will be removable if future construction requires greater stability.

- Removal of slabs in the most desirable portion of the plant for reindustrialization (southern portion) to support future development.

- It is DOE's intent to limit restrictions for Zone 2. Using the data from the industrial use scenario. DOE will evaluate all of Zone 2 for unrestricted use. In areas in which the information indicates there is little chance for unacceptable contamination, restrictions will not be imposed. In addition, the ROD and LUCIP allow excavations deeper than 10 feet with appropriate controls.

2.16 FUTURE MODIFICATIONS TO THE SELECTED REMEDY

As indicated previously in this ROD, additional sampling will be required in certain Zone 2 areas to supplement the limited information about those areas currently available. This new sampling information, or new information gained by other means during the course of implementing the remedial action, might include the need to change some aspect of the remedy being selected here. CERCLA's procedural requirements for making such as post-ROD change are determined by whether the change constitutes an insignificant, significant, or fundamental change to the remedy. Each of these three categories of post-ROD changes has different documentation requirements: (1) a memorandum or note to the post-ROD file for an insignificant or minor change, (2) an explanation of significant differences for a significant change, and (3) a ROD amendment for a fundamental change. In accordance with Section 300.435(c)(2) of the NCP, public notice of either a significant or a fundamental change will be given, and if fundamental change is proposed, a public comment period and opportunity for a public hearing will also be afforded before any ROD amendment is adopted.

2.17 REFERENCES

BJC (Bechtel Jacobs Company LLC) 2004a. *Summary Report for the Mitchell Branch Subwatershed at the East Tennessee Technology Park, Oak Ridge, Tennessee*, BJC/OR-1670, Bechtel Jacobs Company LLC, Oak Ridge, TN.

BJC 2004b. *Summary Report for the K-1007-P Ponds Subwatershed at the East Tennessee Technology Park, Oak Ridge, Tennessee*, BJC/OR-1674, Bechtel Jacobs Company LLC, Oak Ridge, TN.

DOE (U.S. Department of Energy) 1991. *Interim Action Record of Decision for the K-1417-A and K-1417-B Drum Storage Yards, Oak Ridge K-25 Site*, DOE/OR-991, U.S. Department of Energy, Environmental Restoration Division, Oak Ridge, TN.

DOE 1992a. *Federal Facility Agreement for the Oak Ridge Reservation*, DOE/OR-1014, EPA-Region 4, DOE, and TDEC, Washington, D.C.

DOE 1992b. *Interim Record of Decision for the Oak Ridge K-25 Site K-1070 Operable Unit SW-31 Spring*, DOE/OR-1050& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1993. *Record of Decision for the K-1407-B/C Ponds at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, DOE/OR/02-1125& D3, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1994. *Secretarial Policy Statement on the National Environmental Policy Act of 1969*, U.S. Department of Energy, Washington, D. C.

DOE 1995. *Remedial Investigation/Baseline Risk Assessment Report and Feasibility Study for the K-1070-C/D Burial Ground at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, DOE/OR/01-1297& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997a. *Action Memorandum for Rerouting of Sump Discharge from Buildings K-1401 and K-1420, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1610& D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997b. *Action Memorandum for the Mitchell Branch and K-1070-C/D Removal Action, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1611& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997c. *Action Memorandum for the Group 1 Auxiliary Facilities, K-25 Site, Oak Ridge, Tennessee*, DOE/OR/02-1507& D2, U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Oak Ridge, TN.

DOE 1997d. *Action Memorandum for Equipment Removal and Building Decontamination for Buildings K-29, K-31, and K-33 at the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1646& D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997e. *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1486& D4, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *Final Report of the Oak Ridge Reservation End Use Working Group*, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN, July.

DOE 1999a. *Remedial Investigation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee,* Vols. 1-6, DOE/OR/01-1778/V1-6& D1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999b. *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge. Tennessee*, DOE/OR/01-1791& D3, Oak Ridge, TN.

DOE 2000a. *Action Memorandum for the K-25 Auxiliary Facilities Demolition Project Main Plant Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1868& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000b. *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/02-1486& D4, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE et al. (U. S. Department of Energy, Nuclear Regulatory Commission, U.S. Environmental Protection Agency, and U. S. Department of Defense) 2000c. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, DOE/EH-0624, Rev. 1; NUREG-1575; EPA402-R-97-016, August. Available at < http://www.epa.gov/radiation/marssim/>.

DOE 2002a. *Action Memorandum for the Decontamination and Decommissioning of the K-25 and K-27 Buildings, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1988& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002b. *Action Memorandum for the Group II Buildings, Phase II Demolition Project, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1947& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004a. *Focused Feasibility Study for Zone 2 Soils and Buried Waste, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2079& D1/R1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004b. *Addendum to Focused Feasibility Study for Zone 2 Soils and Buried Waste, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-2079& D2/R1/A1, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2004c. *Proposed Plan for Contaminated Soil, Buried Waste, and Subsurface Structures in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee,* DOE/OR/01-2110& D2, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN, March.

DOE, EPA, and TDEC (U.S. Department of Energy, U.S. Environmental Protection Agency, and Tennessee Department of Environment and Conservation) 1999. *Memorandum of Understanding for Implementation of a Land Use Control Assurance Plan (LUCAP) for the United States Department of Energy Oak Ridge Reservation. Attachment: Land Use Control Assurance Plan for the Oak Ridge Reservation,* November.

EPA (U.S. Environmental Protection Agency) 1992. *EPA Region IV RCRA Guidance: Management of Contaminated Media*, Guidance Number TSC-92-02, August.

EPA 1994. *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, Quality Assurance Management Staff, Washington, D. C., September.

EPA 1995a. *Land Use in CERCLA Remedy Selection Process*, OSWER Directive No. 9355.7-04.

EPA 1995b. *Supplemental Guidance to RAGS: Region 4 Bulletins; Human Health Risk Assessment*, Atlanta, Georgia.

EPA 1997. *Health Effects Assessment Summary Tables*, *FY1997 Update*, EPA/540/R-97/036, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA 1998. EPA Directive 9200.4-25, "Use of Soil Cleanup Criteria in 40 CFR 192 as Remediation Goals for CERCLA sites," February 12.

EPA 2000. *Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment Bulletins,* EPA Region 4, Atlanta, GA, originally published November 1995, Website version last updated May 2000. Available at <http://www.epa.gov/region4/waste/ots/healtbul.htm>.

EPA 2001. *Health Effects Assessment Summary Tables (HEAST) for Radionuclides,* Radionuclide Carcinogenicity Slope Factors from the EPA Office of Radiation and Indoor Air. Available at <http://www.epa.gov/radiation/heast/index.html-index>.

EPA 2002. *EPA Region 9 Preliminary Remediation Goals*. Last updated October 2002. Available at <http://www.epa.gov/region09/waste/sfund/prg/index.htm>.

EPA 2003a. *Preliminary Remediation Goals (PRGs) for Radionuclides*. PRG calculator found on the World Wide Web at <http://epa-prgs.ornl.gov/radionuclides/>. Accessed in 2003.

EPA 2003b. *Integrated Risk Information System*, Office of Research and Development, National Center for Environmental Assessment. Available at <http://www.epa.gov/iris/index.html>. Accessed in 2003.

Jacobs 1995. *Archaeological Reconnaissance, K-25 Site, Oak Ridge Reservation, Oak Ridge, Tennessee,* Jacobs ER Team.

LMES (Lockheed Martin Energy Systems, Inc.) 1995. *Site Descriptions of Environmental Restoration Units at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, K/ER-47/R1, Lockheed Martin Energy Systems, Inc., Environmental Restoration Division, Oak Ridge, TN.

MMES (Martin Marietta Energy Systems, Inc.) 1991. *Site Descriptions of Environmental Restoration Units at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, K/ER-47, Martin Marietta Energy Systems, Inc., Environmental Restoration Program, Oak Ridge, TN.

MMES 1995. *Radiological Characterization of Inactive Waste Sites at the Oak Ridge K-25 Site, Oak Ridge Tennessee*, Vols. 1-6, K/ER-218, Martin Marietta Energy Systems, Inc., Environmental Restoration Program, Oak Ridge, TN.

ORNL (Oak Ridge National Laboratory) 2003. *Risk Assessment Information System*, maintained by the University of Tennessee for the Oak Ridge National Laboratory, Oak Ridge, TN. Available at <http://risk.lsd.ornl.gov/rap_hp.shtml>. Accessed in 2003.

TVA (Tennessee Valley Authority) 1991. *Flood Analysis for Department of Energy Y-12, ORNL, and K-25 Plants*, Flood Protection Section of Water Resources Operations Department, Water Resources Division, TVA, Knoxville, TN.

PART 3. RESPONSIVENESS SUMMARY

RESPONSIVENESS SUMMARY

Comments have been grouped into four categories: East Tennessee Technology Park (ETTP) End-State, Institutional Controls, Alternative Selection, and Miscellaneous. Oral comments received at the public meeting held on August 24, 2004, that duplicated written comments were not specifically included to enhance readability of this section. Unique oral comments are included but in a summary form for clarity. Comments or questions received in writing are included as written. No identification of the author of the comments and questions is provided.

ETTP End-State

1. We [the SSAB] recommend the Record of Decision (ROD) commit to and define a program of cleanup and restoration that the public and prospective clients/tenants will find both aesthetically acceptable and compatible with construction of future industrial facilities including excavation, grading, contouring and vegetation where appropriate. This cleanup would address the fate of demolition materials and underground site infrastructure remaining from other remediation and removal action projects. Further, the Board recommends that the cleanup be performed in a manner that will preserve as much as possible of the existing site infrastructure for support of reindustrialization to minimize the burden of local government to reconstruct.

2. There is also a possible upcoming study of ORR by the National Park Service - in regards to evaluating the Manhattan project historical preservation for national park status... how will this effort be coordinated with the cleanup?

   <u>DOE Response to first two comments</u>**: Activities to be conducted under this ROD are intended to be compatible with potential future use of the site for reindustrialization activities and/or historic preservation efforts. Closure activities at the site include the following:**

   - **DOE will coordinate with the National Park Service, as appropriate.**

   - **Remediation to industrial risk-based levels that would also be protective if the land were used for non-industrial purposes (other than residential or agricultural), including historical preservation.**

   - **Placement of concrete on-site in an aesthetically pleasing manner (soil covered) that also supports future development. Future construction in the K-25 Building footprint is considered less likely. Concrete placed in the footprint may consist of larger sized pieces than elsewhere on the site due to the potential future use. If concrete is disposed outside this area, it will be size reduced to allow for future excavation, if necessary.**

   - **Extra effort to avoid damaging important site infrastructure during remediation (main trunk lines or active lines to transferred facilities).**

   - **Backfilling all basements and excavations with soil or concrete. This material will be compacted sufficiently to promote positive drainage. It will be removable if future construction requires greater stability.**

   - **Removal of slabs in the most desirable portion of the plant for reindustrialization (southern portion) to support future development.**

- **Consideration of a future spoils area for rubble that may be generated during future construction activities.**

- **DOE plans to establish a process to verify the absence of contamination below 10 feet to the extent possible to minimize the burdens posed by Land Use Controls.**

3. A concern related to all the alternatives (except the no-action alternative) is the rubble resulting from demolition of "clean" buildings in Zone 2. The possibility exists that the rubble would be left in piles around the site, thereby creating a landscape looking more like a battlefield than a site attractive to potential clients, and thus discouraging economic investment in reindustrialization of the site.

   <u>DOE Response</u>: AH concrete resulting from demolition of buildings will either be disposed in existing Oak Ridge Reservation landfills (e.g., at Y-12) or will be used as fill in basements or excavations at ETTP. No concrete will be left in piles in any of the alternatives. All concrete left at ETTP will be covered with at least enough soil to support vegetation.

4. If the contractor is permitted to utilize the basements of existing structures as fill areas, the contractor must be required to compact those areas so that they are suitable as future building sites. Similarly, if the contractor is permitted to leave concrete pads in place, they should also be required not to damage those pads during the demolition of the buildings that presently sit on those pads. If the contractor is unable to preserve the concrete pads in such a way that they are reusable for future construction, they should be required to demolish the pads completely and return these sites to their original condition. Another comment requested that large pieces of concrete not be used as backfill.

   <u>DOE Response</u>: Please see responses to above comments.

5. Engineered standards for fill material (rubble) and clean topsoil caps should be required wherever demolition and/or removal actions take place. The City is concerned about piles of rubble and concrete slabs left in place, which are not conducive to reindustrialization. Some levels of grading and landscaping are required to control erosion and to ensure that the site is safe, attractive, and feasible for reuse. An additional comment stated that old slabs that have had heavy equipment on it during demolition is useless for future construction and therefore should be removed.

   <u>DOE Response</u>: Please see responses above. There will be no piles of rubble. Backfill material will be placed to allow for positive drainage. The material will be vegetated to control erosion. The site will be left in a safe condition. Slabs that are not contaminated may be removed to enhance future construction opportunities near transferred facilities.

6. I recommend that the cleanup be performed in a manner that will preserve as much as possible of the existing site infrastructure for support of reindustrialization to minimize the burden of local government to reconstruct.

   <u>DOE Response</u>: Please see response to comments above.

7. Another reindustrialization concern is the fate of underground and aboveground utility infrastructure. Infrastructure is a huge asset for ETTP in attracting new construction. The LOG has assumed up to this point that there were plans for utility infrastructure retention for future land uses. Recent discussions have raised the concern that the infrastructure may be irreparably damaged or removed during demolition activities, so the ROD should stipulate that reindustrialization needs will be considered when terminating or dead-ending any utilities.

DOE Response: Please see response to comments above.

8. A comment stated that the railroad is an important element of an industrial site and they hope it will remain.

   DOE Response: Currently no known remediation activities are planned that would disturb the railroad. However, future characterization could indicate that remediation is required. In that case, portions of the railroad may be impacted.

9. A related issue is that the proposed plan does not sufficiently address utilities at the site. For example, the document should describe whether utilities within Zone 2 will be dug up and dismantled, or whether and why existing utilities will remain in the ground. Infrastructure issues will play a significant role in the future viability of the site, and may affect future decisions made by the City and other Partners for Progress.

   DOE Response: Please see responses to comments above which commit to not impacting important utilities that are uncontaminated. DOE will take extra effort to avoid damaging important site infrastructure during remediation (main trunk lines or active lines to transferred facilities). Those buried utilities that are unacceptably contaminated will be excavated or decontaminated. Any residual safety hazards resulting from any remediation will be mitigated with backfilling and capping/covering of exposed large pipelines or holes.

10. A general comment relates to the need to make all decisions regarding restoration of the site that will enhance end-state redevelopment as an unrestricted industrial park. Utility systems should not be destroyed. Concrete slabs should be removed, but if not removed, should not be left in a manner that renders them useless for industrial use. Make certain that rubble used to fill basements is adequately compacted.

    DOE Response: Please see responses to comments above.

11. The redevelopment of East Tennessee Technology Park's Heritage Center (formerly known as K-25) is of the utmost importance to the vitality of the region. The clean-up of this site must commence unabated if we, as a region, ever hope to have this economic resource available to us for redevelopment. The Heritage Center is a key component of the County's overall strategy of economic, diversity. Without this site, Roane County, the City of Oak Ridge and the region will be harmed in their efforts to fully realize our potential to create economic opportunity for current and future citizens. While rapid clean-up of the site is imperative, we must not sacrifice the future of the site to expedient decisions. Toward that end, the site must be cleaned in a manner that will allow, indeed, promote the reuse of the site as a private sector industrial/business park. Rumors of rubble piles and concrete pads that cannot be reused and utility systems broken and abandoned must not be substantiated through actions taken over the next few years, leaving a site in 2008 that cannot be redeveloped. I'm confident that we can finds ways to achieve the dual purpose of clean-up and reuse. I expect those responsible for the clean-up to do so in a manner that leaves a site that can be highly productive for current and future generations of Roane County.

    DOE Response: Please see responses to the above comments.

12. The principal goal of remediation at the ETTP (and the driving force for acceleration of cleanup there) is converting the site to a commercial industrial park. The site's appearance and physical condition after remediation are vitally important to the future success of ETTP as an industrial park.

The LOG is concerned that any voids left after removal of basements and other subsurface structures should be adequately and promptly filled as soon as reasonably practicable. The ROD should stipulate that voids or holes should be quickly and appropriately filled in a manner consistent with anticipated future uses, including industrial, historical-interpretive, and environmental uses. All rubble from clean buildings must be properly reduced to a manageable size, dispersed, and covered with minimum of dirt fill rather than being left in piles. If structures are removed, their sites should be left in a physical condition suitable for immediate grading in preparation for construction, without deteriorating concrete slabs or similar legacy problems.

DOE Response: Please see responses to the above comments.

13. Who decides whether a particular hole is filled with dirt or concrete?

DOE Response: DOE and BJC will work together to develop a plan to determine which holes or basements are filled with concrete based on the contamination levels and availability of demolition concrete when it is time to fill the space.

Institutional Controls

14. Institutional controls are of special concern due to the operation and maintenance of land-use controls after remediation in cases where sale and transfer or lease of the property to non-DOE parties is possible Before DOE may authorize such transfers of property, there must be a reasonable expectation that all necessary institutional controls can be maintained after the transfer and that the new owner understands and is capable of meeting institutional control responsibilities. 1 also recommend that DOE make special provision for the operation and maintenance of land-use controls after remediation in cases where sale and transfer or lease of the property to non-DOE parties is possible. DOE must ensure that all necessary institutional controls can be maintained after the transfer and that the new owner understands and is capable of meeting these responsibilities. If this implementation responsibility cannot be reliably assured, then DOE must retain necessary responsibility and authority for the institutional controls, including ownership of the property if necessary. In addition, the respective responsibilities of DOE and the new owner for any required institutional controls must be documented and communicated to all directly involved parties at the time of transfer, including within property conveyance documents, such as purchase agreements and deeds.

DOE response: The ROD and the Land Use Implementation Control Plan (LUCIP) will specify the long-term institutional controls that are necessary to provide protection under the selected alternative and how they will be implemented, maintained, enforced, and monitored. More details can be found in the ROD and in the upcoming LUCIP. The ROD specifies that DOE, or its successor agencies, will retain ultimate responsibility for the success of these controls.

15. The Record of Decision must clearly and explicitly delineate the roles and responsibilities with regard to long-term stewardship, land use, and other institutional controls, and how these controls will be funded. In particular, the City is concerned that DOE and/or the regulators may envision a role for the City other than normal zoning, building inspection, permitting, etc.

DOE Response: Please see response above. Roles and responsibilities will be identified in the ROD as well as in the LUCIP.

16. Will the City of Oak Ridge have to go through the FFA signatories to get approval for excavating a sewer line? Institutional controls need to be protective but should not impede removal or repair of site infrastructure.

    DOE Response: At this time, FFA approval is not anticipated prior to excavating. The LUCIP will address this issue in more detail.

17. In the event of future failure on the part of any client/tenant to continue all institutional controls necessary for the protection of human health and the environment, responsibility for enforcement of or continued implementation of such controls should return to DOE or its successor agencies.

    DOE Response: See the response above. Although the procedural responsibilities for implementation of land use controls may be transferred to a client/tenant, DOE retains ultimate legal responsibility for enforcement of land use controls.

18. Of special concern are the operation and maintenance of land-use controls after remediation in cases where sale and transfer or lease of the property to non-DOE parties is possible. Such property transfers or leasing is most likely under Alternatives 2 and 3. Before DOE may authorize such transfers of property, there must be a reasonable expectation that all necessary institutional controls can be maintained after the transfer and that the new owner understands and is capable of meeting institutional control responsibilities.

    DOE Response: DOE does not intend to transfer any property to any owners that are not capable of meeting the institutional control responsibilities. Furthermore, DOE will retain the responsibility for providing protection against any residual contamination. More details can be found in the ROD and in the upcoming LUCIP.

19. The [SSAB] Board also recommends that DOE make special provision for the operation and maintenance of land-use controls after remediation in cases where sale and transfer or lease of the property to non-DOE parties is possible. DOE must ensure that all necessary institutional controls can be maintained after the transfer and that the new owner understands and is capable of meeting these responsibilities. If this implementation responsibility cannot be reliably assured, then DOE must retain necessary responsibility and authority for the institutional controls, including ownership of the property if necessary. In addition, the respective responsibilities of DOE and the new owner for any required institutional controls must be documented and communicated to all directly involved parties at the time of transfer, including within property conveyance documents, such as purchase agreements and deeds.

    DOE Response: Please see the response above.

20. The FFS, FFSA, and Plan do indicate that DOE is committed to maintaining necessary LUCs to protect future users of the site. The SSAB, however, wants to see concrete guarantees, including within the final ROD itself, for long-term funding of continued implementation of such measures as well as any other stewardship measures that may prove necessary in the future to satisfy all remediation goals (i.e., protection of worker health, public health, and the environment) in perpetuity, that is, beyond the assumed 25 years of industrial use if necessary. Some type of trust fund may be the most appropriate financial vehicle for this purpose.

    DOE Response: The funding mechanism for all remediation activities, including long-term institutional controls, required in this decision will be that set by the Federal Facility Agreement (FFA). A trust fund is not planned for implementing the Zone 2 decision.

21. Even though there will be a site-wide Record of Decision, the LOG insists that stewardship requirements for Zone 2 be clearly defined in this ROD. At a minimum the requirements should mirror the Melton Valley and Bethel Valley Records of Decision, although a strictly defined stewardship implementation plan is preferred. Several of the LOC's Citizens Advisory Panel (CAP) members actively participate on the Oak Ridge Site Specific Advisory Board (ORSSAB) Stewardship Committee, which serves as the interim Citizens' Board for Stewardship. This committee is providing the annotated outline of the Stewardship Implementation Plan to complement the DOE Oak Ridge Operations Stewardship Strategic Plan, now signed and in place. DOE Oak Ridge Operations should incorporate a stewardship implementation plan in this ROD, following the lead of the DOE sites at Weldon Spring and Rocky Flats. This plan must be acceptable to the other Federal Facility Agreement parties and host communities' governments.

    <u>DOE Response</u>: The ROD contains details on required institutional controls exceeding the details provided in the Melton Valley and Bethel Valley RODs. This ROD is the final ROD for protection of human health from contamination in soil, and institutional controls are a major portion of the selected alternative. Many of the issues addressed in program-level plans on stewardship are outside the scope of any single ROD and, hence, the need for the program plan. The implementation plan for the requirements of this ROD will be documented as a LUCIP— required by the ROD but developed after the ROD is signed.

22. There will be a fence at K-1070-C/D but will there be fences and signs at other locations? The fewer fences and signs, the better for reindustrialization.

    <u>DOE Response</u>: No fence will be required beyond that at the K-1070-C/D Burial Ground. However, a few strategic signs indicating deeper subsurface contamination will be placed, as appropriate.

<u>Alternative Selection</u>

23. Are the burial grounds penetrated by wells? Is there a groundwater plume? Is the nature of materials disposed in them understood?

    <u>DOE Response</u>: The records of disposed materials in the D trenches are sufficient to illustrate that much of the material disposed was equipment that was never used and, hence, uncontaminated. These records were reviewed by representatives of EPA and TDEC! Soil borings ring the trenches, and there are downgradient monitoring wells, none of which shows notable contamination. There are no samples or wells in the trenches, but the combination of disposal records and surrounding media sampling results presents a good understanding of the site. There are much fewer records for material disposed in the C Area. There is no sampling through or directly under this area. Borings at the edge suggest this area may be a source of unacceptable contamination. In both cases, post-ROD data will be collected to close unacceptable data gaps. The ROD calls for monitoring of this area into the future.

24. The K-1070-C/D Burial Ground probably contains wood, paper, plastics, and other materials, some of which are putrescible. Some of the material may oxidize if in contact with the groundwater. If this were a standard landfill, we probably would want to remediate it. Also, could the material be modified in some way to make it unclassified?

    <u>DOE Response</u>: There is a variety of hazardous and non-hazardous material placed in the K-1070-C/D Burial Ground, including the D trenches. That material may degrade over time.

However, the remaining material is most likely to not be a threat to a future industrial worker, or to the groundwater, even with degradation. Management of institutional controls and monitoring is necessary to continue to confirm this conclusion in the future. There is no known way, at this time, to modify the material sufficiently to render it unclassified.

25. Alternative 2 and Alternative 5 are similar with the exception that in Alternative 2 the burial grounds in the K-1070-C/D are fully excavated. Alternative 5, while minimizing the cost of ETTP remediation, does not fully take into consideration the impact to the viability of reindustrialization by private investors. Alternative 2 is a better alternative due to a reduced degree of reliance on long-term institutional controls because of uncertainties about the effectiveness of the controls over long periods of time. Therefore, I encourage the selection of Alternative 2 (Removal of Soil (10ft) and Full K-1070-C/D Removal). Full removal of the burial grounds minimizes the use of institutional controls related to Security required for a classified burial ground. This alternative eliminates any future concerns where digging could occur below the depth that is cleaned up. It also completely eliminates any impact to groundwater from buried waste that could occur over time. This is also the most effective long-term solution to encouraging reindustrialization of ETTP. All the actions required for this alternative are implementable and minimize operation and maintenance costs over the long term. The EMWMF was built to handle remedial action waste so the waste generated from this excavation to the EMWMF is to be expected and is acceptable. This was stated in the FFS. Therefore I endorse Alternative 2.

<u>DOE Response</u>**: The removal (Alternative 2) of the classified equipment in the K-1070-C/D Burial Ground that is not a threat to a future industrial user or a threat to groundwater provides no additional human health or environmental risk reduction as required by CERCLA. The level of contamination remaining at the burial ground under Alternative 5 is the same as throughout the rest of the plant. As with Alternative 2, all material that could cause an unacceptable threat to groundwater is removed under Alternative 5. Because there is no additional risk reduction under Alternative 2, but there are greater industrial or transportation accident risks, it was not selected.**

26. An issue related to Alternative 5 is the potential effect on economic investment in reindustrialization of the ETTP site. In this alternative, only contaminated soils and wastes from the K-1070-C/D burial ground down to 10 feet or to groundwater levels are removed, and classified wastes and materials are left in place. The specter of a 30-acre area surrounded by fencing, warning signs, and armed patrols in the midst of a site otherwise zoned for reindustrialization may discourage investment by potential clients and tenants.

<u>DOE Response</u>**: Please see the response above. Additionally, the security controls will be implemented in such a way to minimize the potential for discouraging investment. Discussions with the Community Reuse Organization of East Tennessee (CROET) indicate they do not believe the continued presence of the burial ground will limit future development.**

27. Alternative 2 which removes all classified materials from the ETTP site should be the preferred alternative for zone 2 for the following reasons: 1. The presence of classified material that must be "guarded" in the middle of a commercial industrial park is inappropriate for the future use of this site. If the classified materials are removed from ETTP, the DOE presence at the site would be limited to occasional inspections and groundwater monitoring instead of full-time security personnel. 2. The cost of removal and permanent secure disposal of the classified material at ETTP is estimated at 43 million. What is the estimate to "manage" the classified material at ETTP? Was the "guarding" of the classified materials included in the cost estimate for alternative 5? If so, how

was the cost determined and how long was the cost estimated to continue? Which agency will be responsible for guarding the classified material after DOE EM has completed cleanup (other than groundwater)? 3. The cleanup of ETTP should be consistent with other brownfield sites across the nation. I know of no sites that would require the type of "presence" that ETTP would if classified materials are left buried on site. In addition, the presence of a " restricted" area at ETTP would not attract new businesses unless there are significant incentives to locate there or it is well disguised and basically "invisible" to the commercial users (such as using the classified burial area as a recreational area for the workers).

DOE Response: Please see responses above. The costs of BOE-implemented security requirements were included in the Alternative 5 costs. Full-time security personnel are unnecessary. DOE would maintain responsibility for implementing these controls. It would take several hundred years of security before the costs between the two alternatives would get close. It is unknown how long the material would remain classified. Regardless, there are also industrial and transportation accidents to consider in unearthing, size reducing, and moving 100,000 cubic yards of equipment and soil. Further, the topography of this area of the site is hilly and less suitable/attractive for cost-effective re-development. Discussions with CROET indicate they do not believe the continued presence of the burial ground will limit future development.

28. The LOG supports removal of all classified materials from this property, in order to facilitate the transition of the ETTP to a viable industrial site. If Alternative 5 is selected (leaving some classified materials in place in the K-1070-C/D Burial Ground), the ROD must include language which clearly stipulates regular (e. g., annual) reappraisals of K-1070-C/D Burial Ground to verify that the classified material meets the current criteria for classification. The sooner the stigma of a "classified" burial ground can be removed, the better. Declassifying these materials would assist with future potential investors and tenants and could make the 30-acre K-1070-C/D Burial Ground area itself available for reindustrialization. The LOC recommends that DOE immediately pursue all available actions to determine if the present classification of material in the K-1070-C/D Burial Ground is still necessary, and if not, begin the process of declassification. Logic tells us that if only a few materials must remain classified, then DOE should explore removing them.

DOE Response: Please see responses above. The ROD stipulates that the need for security controls is to be reviewed annually as part of the annual Remediation Effectiveness Report effort. DOE agrees to diligently work toward de-classifying the materials in the burial ground as soon as reasonable. However, a majority of the large pieces of equipment are classified so there is no benefit to a limited removal activity.

29. As stated in previous comments to DOE, the City of Oak Ridge supports DOE's efforts to cleanup, reuse and convert the ETTP site to a taxable, industrial property. However, the DOE's preferred remediation scenario as described in Alternative 5 of the proposed plan does not appear to provide the level of remediation necessary for a viable industrial park. For example, given the inherent challenges associated with marketing a brownfield site, the presence of a 22-acre classified burial ground on the property would significantly adversely impact any party's ability to market the property to entities other than DOE-related industries. In May 2001, DOE, the Environmental Protection Agency, and the Tennessee Department of Environment and Conservation announced that the Environmental Management Waste Management Facility (EMWMF) would receive classified waste streams from Oak Ridge Reservation CERCLA activities. Thus, the City recommends that DOE remove all such waste from the ETTP burial grounds for emplacement at the EMWMF. Given that the EMWMF will require security and other monitoring measures in perpetuity, it makes sense

to consolidate these materials in one location rather than require long-term maintenance and security at separate locations. Near term costs and risks are obviously a consideration, but the long-range costs to the community of leaving these wastes in various locations around the ORR are incalculable.

DOE Response: Discussions with CROET indicate that the impact on reuse from the presence of the burial ground is probably minor. The EMWMF does have the long-term controls, but security controls for "in perpetuity" are not needed at the burial grounds, just until the material is no longer classified. The remaining controls needed for the burial grounds then are the same as for the rest of Zone 2. There are no very long-term (over 100 years) controls needed at the burial grounds beyond those needed throughout Zone 2.

30. Related to the previous comment are concerns for the potential effect on economic investment in reindustrialization of the site by the preferred Alternative 5's removal of only contaminated soils and wastes from the K-1070-C/D burial ground, but not classified wastes and materials. Key questions appear to be (1) exactly what is meant by the "near term" or "short time" as used in the FFS and Plan, and (2) how to communicate to the targeted business community a realistic assessment of the situation (i.e., that the visible institutional controls on the K-1070-C/D burial ground are strictly to protect classified material, they are not in place for reasons of environmental contamination or other hazards to potential tenants). In any event, about 30 acres of the ETTP would remain unavailable for industrial development for a "short time" under the preferred Alternative 5. Interestingly, the FFS Addendum does state that because the " short-term" time frame cannot be estimated, a period of 30 years is arbitrarily assumed. Please define or explain such terms as "near term" and "short time" (as used for example, in the Plan. pp. 32, 37, 38).

DOE Response: As indicated in the various documents, short-term or near-term refers to the length of time required until the material disposed in the K-1070-C/D Burial Ground is no longer classified. This time frame cannot be estimated. Due to the calculations performed during the present-worth cost analysis, costs beyond 30 years become irrelevant in the present-worth costs. Therefore, 30 years was chosen for costing purposes. Communication to the future business community about the nature of the residual contamination in the burial ground would be the same as the nature of residual contamination throughout Zone 2. The ROD contains more detail than the proposed plan. The future LUCIP will contain even more detail.

31 . Similar concerns for impacts on economic investment (but the institutional controls would be more or less permanently in place) could be expressed for the capping instead of excavation of the K-1070-C/D burial ground as proposed in Alternatives 3 and 4.

DOE Response: DOE agrees that the extent and length of time of institutional controls at the burial ground would be greater under Alternatives 3 and 4 than Alternatives 2 and 5.

32. What are the advantages of leaving classified material in place (other than the cost of removal and disposal)? What are the advantages of removing the classified waste?

DOE Response: The focused feasibility study (FFS) and its addendum lay out the pros and cons of the various alternatives. In summary, leaving the classified material behind lessens the risk of industrial accidents from excavation, size reduction, and transportation as well as saves costs. The benefits from removing the material are no security requirements at the burial ground. There are no definable environmental or human health risk benefits from removing the material.

33. The proposed plan implies that soil removal to 10 feet is protective of industrial workers and groundwater, and that post-remediation restrictions will be placed on digging below 10 feet. The 10-feet limit for digging is impractical as it relates to future use of the site. If known contaminants are below 10 feet, these should be removed. If a site has not been characterized, the area needs to be studied and remediated, if necessary. Otherwise, the restriction should be removed.

<u>DOE Response</u>: The 10-foot horizon for protection of future industrial workers was recommended by the SSAB end-use working group in 1997. The objective was to ensure there was enough depth so that basements could be dug and utilities could be installed or repaired. The depth criterion for the protection of groundwater is not 10 feet as suggested in the comment. Soil or sources that are a threat to groundwater will be removed to the water table or bedrock surface, whichever is shallower. It is DOE's intent to limit restrictions for Zone 2. Using the data from the industrial use scenario, DOE will evaluate all of Zone 2 for unrestricted use. In areas in which the information indicates there is little chance for unacceptable contamination, restrictions will not be imposed. In addition, the ROD and LUCIP allow excavations deeper than 10 feet with appropriate controls.

34. The LOC is very concerned about wastes and contaminated media below a depth of 10 feet. What will be done should cleanup criteria for groundwater or surface water continue to be exceeded after remediation. Would portions of the site be re-excavated to remove contamination sources deeper than 10 feet?

<u>DOE Response</u>: Waste and soil that could be a future threat to groundwater will be removed to the water table or bedrock, if needed. This excavation does not necessarily stop at 10 feet. The criteria generated are based on protecting groundwater to drinking water levels, the most aggressive level. This level has not been set for the cleanup of groundwater, however. Groundwater and/or surface water remediation levels to be set in the future Site-wide ROD are expected to continue to be exceeded after remediation of the soil or burial grounds. The major sources of contamination to groundwater are dense, nonaqueous-phase liquids (DNAPLs) already beneath the water table. The scope of actions below the water table and actual groundwater remediation levels will be set in the Site-wide ROD. No re-excavation is anticipated to be needed because all that can be removed in the unsaturated zone will have been removed, and differing technologies would be most likely applied to the saturated zone.

35. What level of cleanup will apply to the gas station?

<u>DOE Response</u>: The tank will be closed in compliance with the appropriate Underground Storage Tank requirements and to meet the remedial action objectives (RAOs) set for the rest of the site.

36. What elements are included in the O&M costs for the preferred alternative?

<u>DOE Response</u>: The operation and maintenance (O&M) costs include near-term groundwater monitoring until the follow-on Site-wide ROD sets long-term groundwater monitoring requirements, institutional controls (maintenance of a permit program), and patrols for the K-1070-C/D Burial Ground.

37. Several questions were raised in the public meeting about the level of security required for the K-1070-C/D burial ground under Alternative 5.

<u>DOE Response</u>: The FFS assumed that a fence would remain and that there would be periodic patrols by security personnel. It also assumes that there would be no guard facilities located at ETTP. However, the actual requirements cannot be shared due to security concerns.

38. Will all excavations be filled back to existing grade? And can a future developer change the protective 10 foot horizon?

<u>DOE Response</u>: If the material beneath the 10-feet excavation is protective, the excavation may be regraded only and not necessarily reestablished to grade. However, if the deeper material poses a future threat to industrial workers, restoration of the original grade would be required. Institutional controls that will be put in place will not allow a future developer to lessen the protective 10-feet horizon in areas where deeper contamination poses a future threat to industrial workers.

39. There does not appear to be much cost difference between the alternatives ($60 million versus $105 million). None of the alternatives consider restoring the site to unrestricted use. Also, the no action alternative should have associated costs with the DOE walking away.

<u>DOE Response</u>: The cost difference is 75%. An unrestricted alternative was not developed because it would not be seriously considered given the work done to date to select a future vision for ETTP. The feasibility study attempted to focus on the vision that was expressed by the SSAB and by the FFA parties. The no action alternative reflects the assumptions made in the baseline risk assessment, which is used to determine that action is necessary.

<u>Miscellaneous</u>

40. Other issues not adequately addressed for any alternative in the Plan include a more detailed non-traffic accident analysis and the fate of underground utility infrastructure.

<u>DOE Response</u>: A more detailed non-traffic accident analysis was not performed because of the limited quality of the accident statistics in doing this type of work at a DOE facility. As mentioned above, the utilities will not be targeted for remediation unless they are a source or pathway of unacceptable contamination or are in the way of other remediation. Efforts will be made to protect major trunk lines of key utilities.

41. Reasonably foreseeable accidents do not appear to have been adequately addressed in any of these documents with the possible exception of traffic accidents associated with waste and fill transport. Unlike the case with the predicted incidence of traffic accidents, accidents on site resulting from remediation actions may well be a discriminating factor among the five alternatives. Alternative 2, for example, would probably be expected to have a higher probability of serious on-site accidents involving workers than Alternative 4. Please provide adequate analyses of reasonably foreseeable non-traffic-related accidents.

<u>DOE Response</u>: Construction accidents are difficult to predict for DOE sites with the current limited statistics and, therefore, quantification was not attempted. Standard industrial accident statistics would not have been appropriate to use at a DOE facility.

42. What is the status of the historic preservation review of ORR? How will the historic preservation recommendations be incorporated into the accelerated cleanup process?

<u>DOE Response</u>: In general, the residual contamination present will be protective of any foreseeable future use of the site except for residential and agricultural. There is the potential that the K-25 Building footprint may be designated as an historic landmark. Therefore, future construction in this area is considered less likely. Concrete placed in the footprint may consist of larger sized pieces than elsewhere on the site due to the potential future use.

43. What happens if contamination is found during site monitoring following cleanup? Who will be responsible for contamination found at ETTP following cleanup? How will the contamination cleanup be funded and implemented?

    <u>DOE Response</u>: DOE will maintain responsibility for any residual contamination. If this contamination is at unacceptable levels, DOE will remediate it in compliance with this ROD. The funding source is the same as currently used, annual appropriations.

44. What happens if contamination is found at ETTP following cleanup and businesses are disrupted, temporarily closed, or otherwise not able to conduct business? Who will bear the economic hardship (including disruption of business) if further characterization or cleanup is required?

    <u>DOE Response</u>: DOE retains responsibility for all residual contamination at ETTP, along with future characterization or remediation activities, if needed. However, this ROD and subsequent documents will detail out a characterization approach that will minimize this possibility. This ROD will not address the economic elements of future disruption. This discussion would be part of any transfer package.

45. Since the end product of this process will be a Final Record of Decision (ROD) rather than an interim or partial decision document, the LOG feels that the Proposed Plan is generally lacking in substantive detail concerning stewardship, site appearance after cleanup, and infrastructure retention. All of these ingredients are critical to support the East Tennessee Technology Park (ETTP) end-state use as an industrial park and historic site.

    <u>DOE Response</u>: The ROD contains much more information on all three subjects. Even without the specified information, the proposed plan greatly exceeded most in length because of the amount of information that needed to be included to allow the public to select among the alternatives. The requested information is typically not unique to an alternative and, therefore, is being deferred to the ROD. The responses to comments above provide some of the information that is contained in the ROD.

46. DOE Secretary Hazel O'Leary signed the *Secretarial Policy Statement on the National Environmental Policy Act* on June 13, 1994. This policy specifies that "*DOE CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable*". The LOG asks that DOE incorporate NEPA values more fully in the Zone 2 ROD.

    The Zone 2 proposed plan is deficient with respect to connected actions and cumulative impacts. For example, one separate action (separate from this proposed Zone 2 ROD) calls for demolition of "predominantly uncontaminated facilities" at ETTP followed by disposal of the resulting demolition wastes as set forth in the waste handling plan. The Zone 2 remediation and the uncontaminated facilities demolition and disposal action appear to be not only "connected" but "cumulative" and "similar" as well. Impacts of the proposed Zone 2 remediation effort must be considered in combination with an in relation to the impacts of demolition and disposal action and any other actions that may be proposed. The operation of the EMWMF disposal facility in Bear Creek Valley also is a connected action. As far as practicable, the cumulative impacts from all potential sources should be assessed.

<u>DOE Response</u>: All of the actions at ETTP are complementary and provide a significant net benefit to the environment and economy. They are all designed to achieve a specific end-state at ETTP. The CERCLA process allows for multiple actions to be taken in an area, provided they are consistent with the final action. Additionally, the ROD for the EMWMF evaluated cumulative impacts from receiving waste from across the reservation. Information has been included in Section 1.4 of the ROD to illustrate how the various CERCLA actions at ETTP, . Zone 2 are complementary.

47. Why does development of a methodology for management and placement of concrete on-site have to wait until the ROD?

<u>DOE Response</u>: The methodology for management of concrete at ETTP will be developed as part of the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) for characterization in Zone 2, a post-ROD document. Work has begun on this effort. However, all FFA parties desire to have the details in a primary FFA document, and the RDR/RAWP is the next logical document to provide this information.

48. The LOC is concerned that DNAPLs are specifically called out in the Focused Feasibility Study as "not covered in this decision". The concentrations of some chlorinated solvents (trichloroethene) are high enough (1100 times the MCL) to suggest its occurrence as a DNAPL. Why are DNAPLs left out of this decision?

<u>DOE Response</u>: DOE agrees that DNAPLs are likely to be present. However, because the liquids are dense, they have migrated below the water table. Because the DNAPLs are primarily a groundwater problem this issue has been deferred to the Site-Wide ROD.

49. Table 4. Soil Remediation Levels. In footnote "g" why not recalculate the remediation level for mercury is the new concentration is now estimated at Hazard Quotient (HQ) = 1.9 rather than staying with a less conservative value based on out-of-date guidance? Why does Table 3, page 18 cite an exception that mercury is set at an HQ of 1.9 to be consistent with Zone 1? Zone 1 according to Table 4 originally selected a cleanup level to achieve HQ = 1.

<u>DOE Response</u>: The RAO states that if the hazard index (HI) of 1 is exceeded, a risk management decision is made as to whether or not remediation is necessary. The FFA parties discussed that because mercury was not identified as a contaminant of concern, an HQ of 1.9 in both Zones 1 and 2 would be acceptable. The mercury level was placed in the table at EPA's request and not as a primary contaminant of concern. It has not been detected at ETTP at levels of concern for human health.

50. The LOG notes that the new preferred alternative for the remediation of the K-1070-C/D Burial Ground stems from the Oak Ridge Reservation Risk-Based End State Vision, which was presented to stakeholders and local governments as an exercise to fulfill a request by DOE Headquarters. At this time, two of the three suggestions, including this one, have become preferred alternatives. The LOG wants to ensure that cost considerations aside, this alternative remains as protective of human health and the environment as the alternative of complete excavation.

<u>DOE Response</u>: DOE agrees with the comment's desire to ensure a protective alternative. The evaluation of the alternative against the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) criteria (of which cost is only one) is the basis for alternative selection, not the recommendations in the Risk-Based End State Vision. In fact, the vision was developed after DOE had already developed Alternative 5 and was based on the FFS and not the other way around.

51. A memorandum of agreement (MOA) exists between DOE and the State pursuant to Section 106 of the National Historic Preservation Act. This MOA deals with the demolition of the K-25 and K-27 buildings, which are located in Zone 2. The proposed plan does not consider a future use scenario that could include Heritage tourism visitors to the site, a scenario that has been proposed by some local stakeholders to realize the dual goals of Historic Preservation and Economic Development.

    <u>DOE Response</u>: The proposed land use of industrial is sufficient to protect future heritage tourism visitors to the site. Therefore, this remediation decision does not preclude use of the site for tourism. A remediation scenario that only addressed contamination that was a threat to future visitors would not be sufficiently protective of future industrial workers and, therefore, was not developed. Please see responses to other historic preservation questions above.

52. The City is concerned that the Federal Facility Agreement parties may be relying on what some perceive as "CERCLA loopholes", as well as the 1994 DOE "Secretarial Policy Statement on the National Environmental Policy Act" to the detriment of other public involvement requirements pursuant to NEPA. For example, page 5 of the proposed plan states that post-ROD changes can be made with varying levels of public involvement, depending on the nature of the change: "Changes that significantly or fundamentally affect the remedy selected in the ROD will require more explanation and/or opportunity for public comment than those that doe not." The City desires to be consulted prior to any proposed change to a ROD, even if deemed insignificant by the FFA parties. Otherwise, there is no opportunity for input prior to the change of a legally binding document that can have long-term and significant impacts on the community.

    <u>DOE Response</u>: The DOE-ORO Manager has made a commitment to keep the public informed and involved in modifications to/or explanations of significant differences for the CERCLA RODs at the ORR. This process will result in early public knowledge and involvement in necessary changes to signed RODs.

53. A comment requested information on how the various actions across HTTP are connected.

    <u>DOE Response</u>: In summary, each of the early source control actions (e.g., G-Pit removal) stopped future migration of contaminants. The decontamination and decommissioning (D&D) actions not only remove potential future sources but also clear the land to allow access to residual media contamination. Then, the Zone 2 decision is used to remediate the soil. This decision is followed by the Site-wide decision that is used to remediate groundwater, surface water, and sediment. All of these actions, added together, result in protection of the future industrial worker and the environment.

54. As buildings are demolished, sump collection discontinued, and utilities cut, substantial changes to the groundwater flow will be made. Are there plans to add monitoring wells to track these changes to support the Site-Wide ROD? It appears that there will not be enough time before FY08 to make an informed decision about the groundwater.

<u>DOE Response</u>: This ROD will not make requirements for investigation activities for the Site-wide ROD. However, the effects of the changing site conditions are being considered as part of the Site-wide ROD remedial investigation activities, but as the comment notes, not through actual monitoring. DOE believes modeling activities will provide sufficient information to support the groundwater decisions.

55. The FFS, FFSA, and Plan, and the reading public, would benefit from more detailed, and where possible, quantitative, analysis and discussions of, for example, socioeconomics, the Poplar Creek ecosystem, terrestrial habitat, wetlands, and the positive and negative impacts they may incur under the various alternatives. For example, would meeting groundwater MCLs provide adequate protection for fish and other aquatic life of Poplar Creek? How much woodland and wetland would be lost under the various alternatives? Can the impacts on socioeconomics and environmental justice be analyzed and stated in at least a semi-quantitative way, rather than simply stating that "implementation of this alternative [Alternative 5] could assist in achieving stable socioeconomics in the area . . ." (FFS Addendum 2004)?

<u>DOE Response</u>: Socioeconomic impacts were addressed in the supporting documents to the extent possible given the uncertainties surrounding future reindustrialization. However, the remedies associated with Zone 2 have little to no affect on the ecosystem, terrestrial habitats, wetlands, etc., because the actions occur in the industrial area. The effect that meeting maximum contaminant levels (MCLs) would have on aquatic life is beyond the scope of this decision and is an issue for the future Site-wide ROD.

56. With respect to the NEPA issue of irretrievable and irreversible commitment of resources, the documents note that each of the action alternatives would consume fuel and other nonrenewable energy resources, but then contradictorily claim that no impacts from these alternatives are irreversible. This statement appears to be incorrect. Please correct or explain. The documents do acknowledge, however, that loss of EMWMF capacity under any of the action alternatives is in fact an irreversible commitment of resources.

<u>DOE Response</u>: We agree; the fuel consumed is irreversible as the comment notes.

57. CEQ regulations (40 CFR 1508.25) and DOE recommendations (DOE 1993) call for NEPA reviews (EISs specifically) to assess effects of connected, cumulative, and similar actions. Failure to properly assess connected, cumulative, and similar actions can result in improper segmentation or piecemealing of adverse effects and consequent diminishment of their significance. The SSAB is concerned that the FFS and related documents have not adequately addressed the potential for segmentation of impacts and their significance. For example, one separate action (separate from the proposed Zone 2 remediation considered here) calls for demolition of predominantly uncontaminated facilities at ETTP followed by disposal of the resulting demolition wastes as set forth in the WHP2. Both the Zone 2 remediation proposal and the uncontaminated facilities demolition and disposal action appear to be not only connected, but cumulative and similar as well. It is therefore necessary that impacts of the proposed Zone 2 remediation effort be assessed in relation to the demolition and disposal action and any other actions that may be proposed. Special attention should be focused on cumulative impacts of these various actions.

<u>DOE Response</u>: All of the actions conducted in the past, and planned in the future, are designed to achieve remediation of the site to support a future industrial use. The demolition of buildings is a precursor to soil removal and would not result in adverse effects on the environment. The ROD discusses the relationship between building demolition and remediation efforts.

58. FFSA, Socioeconomics and Land Use, p. 23. Please expand the presently limited assessment of socioeconomics and land use. For example, the potential for and effects of a boom or bust effect on local employment and the local economy as the proposed remediation effort begins, peaks, and terminates should be addressed.

<u>DOE Response</u>: The short-term impacts during construction are the same between the alternatives. Because this value is not heavily weighted in remedial decision-making, it was not discussed in the supporting documents. The long-term socioeconomic impacts and land use are discussed because each alternative affects the values differently.

59. The assessment of cumulative impacts in the FFS and related documents appears to be limited to a brief discussion of cumulative transportation impacts from the proposed Zone 2 remediation effort and the building demolition and disposal also planned at ETTP. There are, however, other possible kinds of cumulative impacts (e.g., socioeconomic, ecological, wetland, air pollution, human health, and impacts on future value for industrial development) and other past, present, and future actions (whether federal, non-federal, or private), including numerous past, present, and future removal actions that may contribute to cumulative impacts. These also should be addressed in the FFS and related documents to satisfy DOE's requirement to incorporate NEPA values such as cumulative impact assessment in CERCLA-related review documents. For example, this remediation proposal is directed at soils, buried wastes, and subsurface structures; other media that may contribute to human exposure such as groundwater and surface waters will be addressed in later CERCLA decisions. As far as practicable, the cumulative impacts from all of these potential sources of exposure should be assessed in these documents.

<u>DOE Response</u>: More information on the relationship between the actions has been provided in the ROD. DOE believes it is premature to assess the exposure pathways resulting from the future Site-wide ROD decision in this Zone 2 decision.

60. BJC has submitted an ETTP Waste Handling Plan, Part 2 (WHP2) for "predominantly uncontaminated facilities" to regulators and the public for review. Under Section 3.1 of this plan, demolition wastes satisfying Y-12 WAC would be sent to Y-12 landfills V and VII for construction debris. Wastes not meeting WAC would be disposed of at the EMWMF or at an off-site disposal facility. Later however, the WFIP2 states in Section 4., with little explanation, that ". . . placement of crushed, non-hazardous building debris meeting DOE Order 5400.5 requirements. . . *will occur in ETTP fill areas*" [emphasis added]. Table 2 adds to the confusion by indicating that 13090 cy or 94% of construction debris will be sent to the Y-12 landfills and only 5% (4914 cy) will be "free-releasable concrete," destination to be determined. There is no direct indication in the text or the table that this free-releasable concrete will likely be used as fill at HTTP. Moreover, 4914 cy of concrete is more like 27% by volume of the total waste stream not 5% as indicated in the WHP2, Table 2.

Both the WHP2 and the FFS (and related documents) should explicitly, and where possible, quantitatively set forth the precise disposition of the demolition wastes, and indicate the visual, environmental, and engineering impacts (i.e., engineering integrity of fill areas in terms of siting new industrial facilities) on Zone 2. The Plan, ROD, and WHP2 should clearly demonstrate DOE's commitment to a program of topographic restoration (grading/contouring/revegetation where appropriate) of excavated areas and demolished building rubble piles (including all excavated material not removed from ETTP) that the public and prospective clients/tenants would find both aesthetically acceptable, representative of natural topography in the area, and compatible with construction of future industrial facilities. [Note that the demolition of clean buildings would, or in some cases possibly is being done under a separate action.]

<u>DOE Response</u>: Responses to building waste handling plan (WHP) comments are not provided in this ROD. Please see responses to comments in the End-State portion of the responsiveness summary for the second part of this comment.

61. The non-cancer protection goal for human health under an industrial land use has been revised from an HI of less than 3, as expressed on p. 17 in Draft 2 of the Plan, to a more conservative threshold of less than 1 in Draft 3 of the Plan. The Plan should summarize the areas or sources where an HI of 1 is exceeded.

    Also, Table 1 of the Plan ("Maximum carcinogenic risk and hazard index values . . .") and the associated discussion on p. 16 should clarify that the risk and HI values presented here are for current conditions, not post-remediation conditions (if that is in fact the case).

    <u>DOE Response</u>: The supporting documents provide the level of detail requested on where His of 1 are exceeded. Table 1 is referenced as part of the Site Description and Risk Summary, which describes current, not post-remediation conditions.

62. What is the status of Burial Ground K-1070-G and how will it be remediated if necessary under each action alternative? Is this burial ground the same thing as the G-Pit which was at one time a source of releases to groundwater as discussed in the FFSA, p. 9?

    <u>DOE Response</u>: The supporting documents show that the K-1070-G Burial Ground is assumed to not be sufficiently contaminated to require remediation (page 15 of FFS Addendum). However, the appropriately level of characterization will be conducted to confirm or deny this assumption. If remediation is required, the unacceptably contaminated areas will be excavated. This burial ground is not the same as the G-Pit.

63. The Plan assumes that no RCRA wastes will be excavated. Does this mean that no RCRA wastes are assumed to reside anywhere in the soils of ETTP? How realistic is such an assumption that no RCRA wastes exist on-site?

    <u>DOE Response</u>: The assumption of no Resource Conservation and Recovery Act of 1976 (RCRA) waste only applies to the areas from which the soil is assumed to be excavated. Application of the "no-longer contains" policy of EPA and discussions with TDEC support the assumption that any soil expected to be excavated no longer contains any RCRA waste. There will be monitoring and sampling occurring to confirm or deny this assumption. Any RCRA waste found will be handled according to environmental regulations. If this assumption is inaccurate, it would affect all alternatives almost to the same extent.

64. Soil Conceptual Site Model, Fig. 3, p. 8.: Please explain why this conceptual model does not include non-rad inorganics such as heavy metals, and non-volatile organics, both types of which appear to be present in some soils at HTTP?

    <u>DOE Response</u>: These potential contaminants have not been shown to be major contributors to risk. The conceptual site model is a representation of the major pathways and contaminants causing a potential future risk.

65. FFSA, Table 7, K-1070-C/D Uncertainty Management, p. 21.: The uncertainty management action for the D-trenches is stated to be excavation up to 8 feet in depth across the trench area. Was 10 feet intended here? If not, please explain the 8-feet figure.

<u>DOE Response</u>: As written on page 16, there is a soil cover over the trenches that is assumed to be clean. Therefore, waste volumes assume that only 8 feet of material would need removal and disposal. The remaining 2 feet of soil cover would be set aside and returned to the hole.

66. FFS, Table 2.1, Sources of Soil Contamination, p. 2-10.: Why are there no data available on known or potential contaminants from the K-1435 TSCA Incinerator? This would appear to be a significant deficiency that could compromise assessment of existing conditions in Zone 2 in light of the incinerator's potential for contaminant release in the area.

<u>DOE Response</u>: The Incinerator has been monitored continually for air emissions and is below any regulatory requirements. It is very unlikely that this process is a significant source of soil contamination. However, through post-ROD characterization activities, all unacceptable data gaps will be filled.

67. FFS, Table 2.2, Sources of Soil Contamination, p. 2-16.: Are there no data available at all on known or potential contaminants from the K-1239 Decontamination Pit? As in the preceding comment, this would seem to be a significant deficiency compromising the ability to assess existing conditions within Zone 2.

<u>DOE Response</u>: Through post-ROD characterization activities, all unacceptable data gaps will be filled.

68. FFS, Data Screening Process, p. 3-4.: Section 3.1.3 states that no screening was applied to essential nutrients because none of them have toxicity-based screening levels. Several essential nutrients are in fact listed in the FFS (e.g., Table 3.1 and Appendix A) as COPCs, having exceeded screening PRGs. These include the essential nutrients calcium, chromium, copper, iron, magnesium, manganese, nickel, potassium, sodium, and phosphorus. It seems quite likely that at least some of these nutrients, most of which can be toxic, and some at levels not substantially higher than nutritive levels (e.g., manganese which did exceed PRGs, and selenium, which did not) do have some kind of toxicity-based screening levels established for them. Please confirm or explain the statement that these nutrients have no toxicity-based screening levels when, at the least, PRGs served as screening levels for these nutrients.

<u>DOE Response</u>: Please see the text in the FFS immediately after Table 3.1. This text illustrates that there are two types of contaminants of potential concern (COPCs) listed in Table 3.1, quantitative based on exceeding a screening level and qualitative based on there being no screening level. EPA Region 4 guidance lists calcium, chloride, iodine (there were no ETTP soil data for iodine), magnesium, phosphorus, potassium, and sodium in the essential nutrient category, which has no screening levels. Thus, for this human health risk assessment, these essential nutrients were not eliminated as COPCs. They were included in Table 3.1 as qualitative COPCs. The other chemicals listed in the comment (chromium, copper, iron, manganese, and nickel) all have screening preliminary remediation goals (PRGs) and were evaluated against their respective PRGs in order to determine their COPC status (i.e., the PRG screen was applied to all chemicals that had PRGs).

69. FFS, Proposed Cap, Fig. 6.4, p. 6-24.: Please explain the significance of the yellow area in the map (perhaps the boundary of the proposed cap?).

<u>DOE Response</u>: The yellow areas represent the boundaries of Federal Facility Agreement sites.

70. FFS, Magnitude of Residual Risks, p. 7-7.: Please explain why "Any area smaller than 50 feet in diameter cannot support an exposure duration of 10 % of a worker's time . . . " Is it possible, for example, that a clerk or a foreman might spend considerably more than 10% of his time in an office located at a "hot spot" smaller than 50 feet in diameter?

<u>DOE Response</u>: These hot spots are associated with soil contamination and, hence, would only support exposure to an outdoor worker. It is very unlikely that someone would be standing in the same spot outdoors for 20 days a year for 25 years under an industrial use.

APPENDIX A

FFA SITES IN ZONE 2

Table A.1. ETTP Zone 2 FFA sites

FFA site[a] (SWMU No.)	Problem type	Action
Building K-1423 Grease Burial Site (C123)	Soil to protect workers	Verification sampling*
J. A. Jones Cleaning Area	Soil to protect workers	Verification sampling*
K-1004-J Underground Tanks (R074)	Soil to protect workers	Excavation**
K-1004-J Vaults	Soil to protect workers	Verification sampling*
K-1004-L Recirculating Cooling Water Lines Leak Sites (C003X)	Soil to protect groundwater	Verification sampling*
K-1004-N1 Recirculating Cooling Water Lines	Soil to protect groundwater	Verification sampling*
K-1015 Laundry Pit (W001)	Soil to protect workers	Verification sampling*
K-1024 Dilution Pit (R082)	Soil to protect workers	Verification sampling*
K-1031 Waste Paint Accumulation Area (R055)	Soil to protect workers	Verification sampling*
K-1035 Acid Pits/Drain Lines (R083)	Soil to protect workers	Excavation**
K-1035 Gasoline Station	Soil to protect workers	Verification sampling*
K-1044 Heavy Equipment Repair Shop	Soil to protect workers	Verification sampling*
K-1045-A Waste Oil Burning Pit (C129)	Soil to protect workers	Verification sampling*
K-1064 Drum Storage and Burn Area (R007)	Soil to protect workers	Excavation**
K-1064-G Drum Deheading Facility (R020)	Soil to protect workers	Verification sampling*
K-1066-B Cylinder Storage Yard, Northeast K-1423, Residual Soil Contamination	Soil to protect workers	Verification sampling*
K-1066-E Cylinder Storage Yard, North K-832, Residual Soil Contamination	Soil to protect workers	Verification sampling*
K-1066-K Cylinder Storage Yard Pad and Soil	Soil to protect workers and subsurface structure	Verification sampling*
K-1070 Pits	Soil to protect workers and groundwater	Excavation**
K-1070-B Old Classified Burial Ground (R002)	Buried waste	Excavation**
K-1070-C/D Classified Burial Ground (R005)	Buried waste	Excavation**
K-1070-G Burial Ground (R054)	Buried waste	Verification sampling*
K-1071 Concrete Pad	Subsurface structure	Verification sampling*
K-1098-C Asphalt Plant	Soil to protect workers	Verification sampling*
K-1131 Neutralization Pile (C074)	Soil to protect workers	Verification sampling*
K-1206-E Sandblasting Residue (C076)	Soil to protect workers	Verification sampling*
K-1210 Recirculating Cooling Water Lines	Soil to protect groundwater	Verification sampling*
K-1217 Metalizing Shop Soils	Soil to protect workers	Verification sampling*
K-1218 Coded Chemicals Storage Facility	Soil to protect workers	Verification sampling*
K-1232 Chemical Recovery Facility Basins/Drain Lines (R014)	Soil to protect workers and subsurface structure	Excavation**
K-1232 Equalization/Neutralization Tanks (P006)	Soil to protect workers and subsurface structure	Verification sampling*
K-1236 Paint Shop	Soil to protect workers	Verification sampling*
K-1303 Mercury Distillation and Recovery Unit Soils (R086)	Soil to protect workers	Verification sampling*
K-1401 Acid Line (R013)	soil to protect groundwater	Verification sampling*
K-1401 Degreasers (C005)	Soil to protect workers	Verification sampling*
K-1401 Sump	Subsurface structure	Verification sampling*
K-1401-NB Basement (Northwest)	Subsurface structure	Verification sampling*
K-1407 Contaminated Debris (C132)	Soil to protect workers	Verification sampling*
K-1407-C Pond Pipeline (W002)	Soil to protect workers and groundwater	Verification sampling*
K-1407-C Soil Piles	Soil to protect workers	Verification sampling*
K-1410 Neutralization Pits/Drain Lines (R011)	Subsurface structure	Verification sampling*
K-1413 Treatment Basins/Process Lines (R015)	Subsurface structure	Excavation**
K-1414 Garage Diesel Tank/Soils	Soil to protect workers and groundwater	Verification sampling*
K-1417-A Drum Storage Yard (R033)	Subsurface structure	Verification sampling*

Table A.1. ETTP Zone 2 FFA sites (continued)

FFA site[a] (SWMU No.)	Problem type	Action
K-1417-B Drum Storage Yard (R033)	Subsurface structure	Verification sampling*
K-1420 Contaminated Drum Storage (C067)	Subsurface structure	Excavation**
K-1420 Sump	Subsurface structure	Verification sampling*
K-1420 Tank/Drain Lines (R016)	Soil to protect workers and groundwater	Excavation**
K-1420 Waste Oil Storage Pad (R010)	Subsurface structure	Excavation**
K-1503 Neutralization Pit (R047)	Soil to protect workers	Verification sampling*
K-25 Site North Trash Slope (C106)	Soil to protect workers	Verification sampling*
K-27/K-29 Recirculating Cooling Water Lines Leak Sites (C003h)	Soil to protect groundwater	Verification sampling*
K-300 Area Service Station	Soil to protect workers	Verification sampling*
K-31 Recirculating Cooling Water Lines Leak Sites (C003j)	Soil to protect groundwater	Verification sampling*
K-33 Recirculating Cooling Water Lines Leak Sites (C003k)	Soil to protect groundwater	Verification sampling*
K-732 Switchyard Soils (R075b)	Soil to protect workers	Verification sampling*
K-762 Switchyard Soils (R075c)	Soil to protect workers	Verification sampling*
K-762 Valve Vaults 1 and 2	Subsurface structure	Verification sampling*
K-792 Switchyard Soils (R075d)	Soil to protect workers	Verification sampling*
K-801-AA Valve Vault	Subsurface structure	Verification sampling*
K-801-BB Valve Vault	Subsurface structure	Verification sampling*
K-801-H Cooling Tower Basin (C003e)	Subsurface structure	Verification sampling*
K-802 Gasoline Storage Tank (UST)	Subsurface structure	Verification sampling*
K-832-H Cooling Tower Basin (C003i)	Subsurface structure	Verification sampling*
K-835 Venturi Vault	Subsurface structure	Verification sampling*
K-861 Cooling Tower Basin (C003l)	Subsurface structure	Verification sampling*
K-892-G Cooling Tower Basin (C003m)	Subsurface structure	Verification sampling*
K-892-H Cooling Tower Basin (C003n)	Subsurface structure	Verification sampling*
K-892-J Cooling Tower Basin (C003o)	Subsurface structure	Verification sampling*
K-897-A Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-B Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-C Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-D Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-E Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-F Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-G Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-H Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-J Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-K Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-L Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-M Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-N Oil Containment Structure	Subsurface structure	Verification sampling*
K-897-P Oil Containment Structure	Subsurface structure	Verification sampling*
T-17 Light Equipment Garage Tank, Slab and Soil	Subsurface structure and soil to protect workers	Verification sampling*
T-21 Oil/Grease Station	Soil to protect workers	Verification sampling*
T-27/T-5 Pipe Welding Shop	Soil to protect workers	Verification sampling*
South Plant Area Lab Drain Lines (R017)	Soil to protect workers	Verification sampling

[a]Subsurface features of ETTP decontamination and decommissioning sites part of earlier decisions are also included in the scope. The action is verification sampling.

*Verification sampling conducted followed by excavation if results are above remediation levels.

**Anticipated excavation in the area. Exact boundaries may require further delineation.

ETTP = East Tennessee Technology Park. SWMU = solid waste management unit.
FFA = Federal Facility Agreement. UST = underground storage tank.

APPENDIX B

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CONTENTS

TABLES

ACRONYMS

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
CAA	Clean Air Act of 1970
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CWA	Clean Water Act of 1972
DOE	U.S. Department of Energy
EDE	effective dose equivalent
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
EU	exposure unit
FFA	Federal Facility Agreement
FR	Federal Register
HBL	health-based limit
LDR	land disposal restriction
LLW	low-level waste
NCP	National Contingency Plan
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act of 1966
NLCI	no longer contained-in
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
ORR	Oak Ridge Reservation
OSWER	Office of Solid Waste and Emergency Response
PCB	polychlorinated biphenyl
ppm	parts per million
RACM	regulated asbestos-containing material
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act of 1976
ROD	Record of Decision
STP	Site Treatment Plan
TBC	to be considered
TDEC	Tennessee Department of Environment and Conservation
TEDE	total effective dose equivalent
TPH	total petroleum hydrocarbon
TSCA	Toxic Substances and Control Act of 1976
UST	underground storage tank
VOC	volatile organic compound
WAC	waste acceptance criteria

B.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Sect. 121 specifies that remedial actions for cleanup of hazardous substances must comply with federal or more stringent state environmental laws that are determined to be applicable or relevant and appropriate requirements (ARARs) for the hazardous substances or particular circumstances at a site or obtain a waiver [40 *Code of Federal Regulations* (CFR) 300.430(f)(l)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. In addition, per 40 CFR 300.400(g)(3), other advisories, criteria, or guidance may be considered in determining remedies [the so-called to-be-considered (TBC) guidance category]. In accordance with 40 CFR 300.400(g), the U.S. Department of Energy (DOE), the Tennessee Department of Environment and Conservation (TDEC), and the U.S. Environmental Protection Agency (EPA) have identified the specific ARARs and TBCs for the specified actions. The preferred remedy complies with all ARARs/TBCs related directly to implementing the selected action and does not require an ARAR waiver(s). Tables B.1, B.2, and B.3, respectively, list the chemical-, location-, and action-specific ARARs/TBCs for component actions for the preferred remedy. A brief description of key ARAR/TBC issues follows.

B.1 CHEMICAL-SPECIFIC ARARs/TBCs

Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, and air) for specific hazardous substances, pollutants, or contaminants and are listed on Table B.1 and discussed below.

Radiation Protection. Since the soil under the selected alternative will be remediated to industrial (restricted) use levels rather than residential (unrestricted) levels based on projected land use, radioactively contaminated soils at certain levels will be left in place under all action alternatives. The radiation dose to members of the public must not exceed the 100 mrem/year total effective dose equivalent (TEDE) from all sources, excluding dose contributions from background radiation, medical exposures, or voluntary participation in medical/research programs [10 CFR 20.1301(a)(l)], and must be reduced below this limit as low as reasonably achievable (ALARA) per 10 CFR 20.1101(b). This dose limit, which would be relevant and appropriate, addresses exposure to radiation from all sources and activities (including both operations and removal/remedial actions) at a facility. In addition, DOE Order 5400.5 limits radiation dose exposure to an effective dose equivalent (EDE) of 100 mrem/year from all exposure pathways and all DOE sources of radiation as measured at the plant boundary. The overriding principle of the DOE Order is that all releases of radioactive material shall be ALARA. Under DOE Order 5400.5(IV)(4)(a), guidelines for residual concentrations of radionuclides in soil should be derived from the basic dose limit using an environmental pathway analysis. DOE Order 5400.5(IV)(4)(a)(2) also includes generic guidelines for residual concentrations of radium-226, radium-228, thorium-230, and thorium-232 of 5 pCi/g averaged over the first 15 cm of soil or 15 pCi/g averaged over 15-cm-thick layers of soil below the first 15 cm. These levels are consistent with EPA standards under 40 CFR 192.12, which are considered relevant and appropriate requirements. These requirements are included as chemical- and action-specific ARARs/TBCs in Tables B.1 and B.3 and are also discussed under "Removal of Contaminated Soil" below.

Risk-based remediation levels for East Tennessee Technology Park (HTTP) Zone 2 radioactively contaminated soils were developed based on the ARARs and TBC guidance discussed here and considering natural background concentrations. The proposed actions (e.g., removing or covering contaminated soil) will limit exposures to radioactive contaminants and protect all users to a nsk level within the target risk range, consistent with the EPA guidance on CERCLA risk levels for radionuclides [EPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-18, August, 1997, and Directive 9200.4-25, February 1998] and DOE Order 5400.5 TBC requirements for residual radioactivity in soils.

Polychlorinated Biphenyl (PCS) Contamination. Due to the presence of PCBs within a portion of the exposure units (EUs), the requirements of 40 CFR Part 761 are potential ARARs for PCB-contaminated soil remaining in situ. The regulations provide for the development of risk-based cleanup standards should a person wish to clean up or dispose of PCB remediation waste in a manner other than those prescribed in 40 CFR 761.61 (a) ["self-implementing" option]. Risk-based cleanup levels may be derived and established in coordination with the regulatory agency, as specified in 40 CFR 761.61(c), to comply with the Toxic Substances and Control Act of 1976 (TSCA) PCB requirements. Although these requirements do not mandate a specific concentration, the rule does require that cleanup levels be developed and established. Remediation levels for Zone 2 PCB-contaminated soils were developed based on risk.

Underground Storage Tank (UST) Releases. A number of petroleum USTs were previously closed and either removed from the ground or filled and left in place. Rules of the TDEC Chap. 1200-1-15-.07(4) requires that, for previously closed petroleum UST systems, an excavation zone assessment be done and the system closed in accordance with Rules of the TDEC 1200-1-15-.07 if releases attributable to the UST may pose a current or potential threat to human health and the environment. TDEC's UST System Closure Assessment Guidelines (July 15, 2000) ["guidelines"] provide the standard procedure for UST system closure in accordance with Rules of the TDEC1200-1-15-.07. The guidelines note that soil contaminated at levels exceeding 5 parts per million (ppm) benzene and/or 100 ppm total petroleum hydrocarbons (TPH) or groundwater contaminated at concentrations exceeding 0.005 ppm benzene and/or 0.1 ppm TPH is considered "impacted" and must be remediated in accordance with the UST regulations under Rules of the TDEC Chap. 1200-1-15-.06.

Rules of the TDEC Chap. 1200-l-15-.06(7)(e) requires that impacted soil or groundwater be remediated to meet the cleanup levels listed in Appendices 4 and 5 of the rule. The cleanup levels are based on whether the groundwater is considered a drinking water or non-drinking water source; varying levels are given for soil based upon the soil permeability and the groundwater classification. Rules of the TDEC Chap. 1200-1-15-.06(7)(e)(4), however, allows for a site-specific, risk-based cleanup standard if the owner/operator believes the site should not be subject to the cleanup levels in Appendices 4 and 5. Such a site-specific standard must provide for adequate protection of human health and the environment. *TDEC Technical Guidance Document 008* (July 1, 2002) provides guidance for calculating and establishing such site-specific cleanup levels. For sites where the background levels of petroleum, due to natural conditions, exceed the cleanup levels in Appendices 4 and 5, the owner/operator is only required to clean up to natural background levels [Rules of the TDEC Chap. 1200-l-15-.06(7)(e)(2)]. Site-specific remediation levels for Zone 2 soils potentially impacted by UST releases were developed based on risk and in accordance with these ARARs/TBCs.

B.2 LOCATION-SPECIFIC ARARS/TBCS

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations (e.g., wetlands, floodplains, critical habitats, historic districts, and streams). Table B.2 lists federal and state location-specific ARARs for the protection of cultural or sensitive resources that are discussed here.

Archaeological Resources. A number of cemeteries exist at HTTP [i.e., Gallaher, Welcker, Slave, Ellis, and Shelton cemeteries]. Potential adverse effects from remediation activities on such properties will be considered, and measures to minimize or mitigate them will be evaluated per applicable requirements.

Several buildings/structures within Zone 2 are contributing structures to the National Register of Historic Places under the National Historic Preservation Act of 1966 (NHPA). The K-25 Building is considered a signature building of the Manhattan Project. Clearing/grubbing and/or excavation activities could potentially adversely affect these structures directly or the visual presentation of these structures. NHPA Sect. 106 requires that a proposed activity consider impacts to buildings or structures that are considered historic properties. Adverse effects on historic properties during clearing and excavation activities will be taken into account and measures to minimize or mitigate them will be evaluated per the applicable NHPA requirements.

Aquatic Resources. All land-disturbing construction activities (e.g., excavation, trenching, capping, soil covers, etc.) with the potential to impact surface water runoff must be designed and implemented using best management practices (BMPs), as well as erosion and sedimentation controls, to comply with aquatic resource alteration requirements. Additionally, the Clean Water Act of 1972 (CWA), as amended. Section 404 requirements for protection of aquatic resources at 40 CFR 230.10 must be met if the action causes any discharge of dredged or fill material into aquatic ecosystems.

Wetlands/Floodplains. No wetland areas are within the Zone 2 areas that will be excavated, and none of the Zone 2 areas are within 100-year floodplains. Certain wetlands/floodplains outside the Zone 2 areas (e.g., adjacent to the Clinch River or Poplar Creek), however, could potentially be impacted by remediation activities. In accordance with Executive Order 11990 and 10 CFR 1022, remedial actions must avoid, to the extent possible, long- and short-term adverse impacts to wetlands and floodplains. Mitigation measures listed in 10 CFR 1022.12, which include minimum grading requirements, runoff controls, and design and construction constraints, would need to be implemented to restore/preserve the beneficial values of the wetlands/floodplains. If the action involves discharge of dredged or fill material into waters of the United States including jurisdictional wetlands, federal CWA regulations at 40 CFR 230 will be applicable. In addition, Rules of the TDEC Chap. 1200-4-7-.04(7)(b)(l) would be a potentially applicable ARAR. This rule requires mitigation where an activity would result in an appreciable permanent loss of resource value of wetlands. Compensatory measures must be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation for wetlands that are greater than 0.25 acres in size. Mitigation strategies will be detailed in the Remedial Action Work Plan (RAWP) for Zone 2 soils, if detailed remedial design indicates there may be an impact to nearby wetlands and/or floodplains, and adverse effects will be avoided or minimized.

Threatened or Endangered Species. Two state-listed threatened plant species are located in the K-901 Area, which is in Zone 1, near the rock ledges on the Clinch River shoreline; *Druba ramossimo* is listed as a "species of special concern," and *Aureolaria patula* is listed as "threatened" (Awl et al. 1996). No federally designated threatened or endangered species have been identified in Zone 2, but there is a potential for Zone 2 actions to impact the sensitive species in Zone 1, which surrounds Zone 2. Precautions will be taken such that state-listed species in Zone 1 will not be adversely affected by actions for Zone 2 that are included as part of the preferred remedy.

B.3 ACTION-SPECIFIC ARARS/TBCS

Action-specific ARARs include operation, performance, and design standards and requirements or limitations based on the waste types, media, and remedial activities. Selection of a specific remedial action for a site will invoke the pertinent action-specific ARARs. Component actions for the preferred remedy include general construction/excavation activities; removal of contaminated soil and buried waste, removal of slabs and subsurface structures such as paper-insulated lead cable lines and utilities, building basements, pits, pipelines, or USTs; waste staging, storage, management and disposal; water treatment; institutional controls; and transportation. ARARs for these components are listed in Table B.3 and summarized below.

General Construction/Excavation Activities. During the preparation phase of remedy implementation, limited grubbing and clearing of land may be required prior to capping or excavation.

Requirements for the control of stormwater runoff and fugitive dust are listed in Table B.3 and are ARARs for all site preparation, construction, demolition, and excavation activities. Stormwater discharges from activities at industrial sites involving construction operations that result in the disturbance of 1 acre or more total land are controlled under the CWA National Pollutant Discharge Elimination System (NPDES) regulations. Reasonable precautions must be taken that include the use of BMPs for erosion control to prevent stormwater runoff (40 CFR 122; Rules of the TDEC Chap. 1200-4-10-.03 and General Permit No. TNR10-0000 Part HI D.2.a) and the application of water on exposed soil/debris surfaces to prevent fugitive particulate matter from becoming airborne (Rules of the TDEC Chap. 1200-3-8-.010). Diffuse or fugitive emissions of radionuclides to the ambient air from the remedial construction and operation activities, which are only one of potentially many sources of atmospheric radionuclide emissions at a DOE facility, must comply with the Clean Air Act of 1970 (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAPs) in 40 CFR 61.92. NESHAPs limit ambient air radionuclide emissions from DOE facilities to levels that would prevent any individual from receiving an EDE of 10 mrem/year or more (40 CFR 61.92).

Removal of Contaminated Soil. The proposed remedial activities include excavation of soil and waste at several of the EUs. The major contaminants in the excavated soil are anticipated to be uranium and cesium, although other radionuclides, along with metals and orgarucs, have been shown to be present at low levels. Soils removed as part of these actions may be considered TSCA PCBs, low-level waste (LLW), and/or Resource Conservation and Recovery Act of 1976 (RCRA) solid, hazardous, or mixed waste, depending on the extent of contamination, and will be disposed of at the Environmental Management Waste Management Facility (EMWMF) or an appropriate off-site facility. It is anticipated that no treatment other than potentially dewatering will be needed prior to disposal; however, the soil will be sampled to ensure compliance with the EMWMF or off-site facility waste acceptance criteria (WAC). CERCLA Section 104(d)(4) states, "where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions." Section 104 (d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit. Under this authority, all on-Oak Ridge Reservation (ORR) disposal facilities and noncontiguous sites where CERCLA response actions will generate waste requiring disposal are considered as a single facility (i.e., "on-site" for response purposes). Thus waste disposal at the EMWMF or other on-ORR disposal facility would be considered "on-site" disposal.

The implementation assumes that no RCRA-listed waste is present in the soil. Due diligence efforts are currently being conducted, however, to identify and review historical records to determine if contaminated media associated with remedial activities may contain listed wastes. If this research reveals the potential presence of RCRA-listed waste in any of the soil being addressed under this decision, the soil will be managed accordingly. EPA's contained-in policy and its guidance for the management of remediation waste under RCRA (EPA 1998), as well as EPA Region IV guidance for the management of RCRA-contaminated media (EPA 1992), allow a generator to determine that environmental media no longer contain listed waste if the medium meets site-specific, risk-based criteria approved by EPA or an authorized state. The policy also includes provisions to allow the use of a risk assessment protocol to determine that the environmental medium no longer contains a listed hazardous waste. EPA Region 9 industrial preliminary remediation goals (PRGs) will be used for making the initial "no longer contains" determinations for soils remediated under this action. If the soils are determined to contain listed wastes at concentrations in excess of these PRGs, further site-specific risk evaluation may be performed to establish site-specific, risk-based criteria. These criteria will be based on the proposed future land use for ETTP (i.e., industrial). If any RCRA hazardous soil is removed from the areal extent of contamination for subsequent disposal in a land-based unit, the pertinent RCRA land disposal restriction (LDR) treatment standards for hazardous waste in 40 CFR26SAQ or 40 CFR 268.49 must be met. In the unlikely event these treatment standards cannot be met, a site-specific treatment variance or a waiver of ARARs may also be pursued and appropriately documented as a post-Record of Decision (ROD) change, if deemed necessary.

Operational history for Zone 2 indicates that disposal of regulated PCBs may have occurred after 1979, thus subjecting these sites to cleanup under 40 CFR 761. Remediation levels for PCB-contaminated soil remaining in situ will satisfy the risk-based cleanup standards of 40 CFR 761.61(c) for bulk PCS remediation waste. Excavated soil contaminated with PCBs is considered bulk PCB remediation waste and must be handled accordingly in compliance with 40 CFR 761.61. Any RCRA hazardous soils removed from an area for subsequent disposal in a land-based unit must meet the pertinent RCRA LDR treatment standards for hazardous waste at 40 CFR 268.40 or 40 CFR 268.49. In the unlikely event these treatment standards cannot be met, a site-specific treatment variance or a waiver of ARARs may also be pursued and appropriately documented as a post-ROD change if deemed necessary and all Federal Facility Agreement (FFA) parties agree. Radioactively contaminated soils must be managed in accordance with the requirements of DOE Orders 5400.5 ("Radiation Protection of the Public and the Environment") and 435.1 ("Radioactive Waste Management"). Remediation levels for radioactive soils remaining in situ were developed to protect the appropriate human receptor considering the requirements of DOE Order 5400.5(IV)(4)(a) for residual radioactivity left in place. Excavated radioactive soils would be considered LLW; DOE Order 435.1 requires generators of LLW to characterize and segregate LLW to minimize the amount of LLW generated. See the detailed waste generation, characterization, management, treatment, and disposal requirements listed in Table B.3.

Removal of Buried Waste, Surface Slabs, and Subsurface Structures. The selected alternative also includes excavation of buried wastes and removal of concrete slabs and subsurface structures such as cable lines, utilities, process or waste pipelines, concrete building basements, pits, or USTs, as necessary. The buried waste in the various burial grounds consists of construction and demolition debris, equipment, soil, and other heterogeneous materials. These wastes and soils will be removed using standard excavation techniques. Excavated debris and wastes will require characterization under the RCRA requirements for hazardous and solid wastes, the Nuclear Regulatory Commission (NRC) and DOE requirements as LLW, NESHAPs requirements for regulated asbestos-containing material (RACM), and the TSCA requirements for PCB wastes (see Table B.3). Handling of the excavated materials must be in compliance with the detailed waste generation, characterization, management, treatment, and disposal requirements listed in Table B.3 for the particular type of waste generated. Excavated debris that is determined to be hazardous and is removed from the area for subsequent disposal in a land-based unit must meet the pertinent RCRA LDR treatment standards for hazardous waste at 40 CFR 268.40 or the alternative standards for hazardous debris at 40 CFR 268.45. As with hazardous soils, in the unlikely event these treatment standards cannot be met, a site-specific treatment variance or a waiver of ARARs may also be pursued and appropriately documented as a post-ROD change, if deemed necessary and all FFA parties agree.

Under the selected alternative, temporary or interim storage or staging of excavated soils, waste, and debris may be required prior to characterization and disposal. These areas will be in close proximity to the Zone 2 areas, are necessary for implementation of the remedial action, and are therefore deemed to be "on-site" under CERCLA § 121(e)(l) [see also 40 CFR 300.400(e)(l)]. The stockpiled wastes will be scanned, characterized, and disposed of at the EMWMF, as appropriate. If the chemical and/or radiological WAC for the EMWMF cannot be achieved, the waste will be shipped off-site to a permitted facility. After removal of the waste, the site will be sampled to demonstrate that risk-based remediation goals have been achieved, and the area(s) will then be backfilled with clean soil and/or concrete that meets remediation levels and recontoured to original conditions. Storage of hazardous waste restricted from land disposal is prohibited unless storage is solely for the purpose of accumulating such wastes to facilitate proper recovery, treatment, or disposal [40 CFR 268.50(a)]. Such wastes may be accumulated on-site, provided the waste is stored in compliance with 40 CFR 262.34 and 40 CFR 264.171-178 (see Table B.3). Section 105 of the ORR Federal Facility Compliance Agreement, as implemented through the ORR Site Treatment Plan (STP) and the TDEC Commissioner's Order for the ORR STP, effective October 2, 1995, will allow storage of mixed wastes at the ORR for periods longer than 1 year without meeting LDRs, pending development of treatment capacity.

Water Treatment. Wastewater collected during excavation, well-drilling, dewatering, or decontamination activities will be characterized and transported to the Central Neutralization Facility (CNF) for treatment or another ORR wastewater treatment facility. On-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA (i.e., are NPDES-permitted) are exempt from the requirements of RCRA Subtitle C for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment [40 CFR 264.1(g)(6); 40 CFR 260.10; 40 CFR 270.1(c)(2); and 53 FR 34079, September 2, 1988]. Discharge of wastewaters that are hazardous only because they exhibit a hazardous characteristic and which are otherwise restricted from land disposal is not prohibited if such wastes are managed in a treatment system that subsequently discharges to waters of the United States pursuant to a permit issued under Section 402 of the CWA [40 CFR 268. l(c)(4)(i); Rules of the TDEC Chap. 1200-1-11-.10(l)(a)(30(iv)(I)].

Institutional Controls. Zone 2 will not support unrestricted use post-ROD because hazardous substances will remain in place above unrestricted use levels. Per the National Contingency Plan (NCP) [40 CFR 300.430(a)(l)(iii)] and Rules of the TDEC Chap. 1200-1-13-.08(10), institutional controls are required to prevent or limit exposure to hazardous substances left in place that may pose an unreasonable threat to public health, safety, or the environment. Institutional controls, including land use controls, will be used to prevent access to residual contamination below 10 ft and to prevent inappropriate use of the site that may be inconsistent with the land use controls selected in this ROD. These controls will apply after completion of the remedial actions and will be described in the Land Use Control Implementation Plan in accordance with the Land Use Control Assurance Plan for the ORR (which established procedures for assuring the long-term effectiveness of such controls throughout the ORR). These controls include the filing of property record and deed notices and restrictions to warn and restrict potential users of the groundwater and soil areas in Zone 2 that contain residual contamination. Appropriate deed restrictions will be recorded in accordance with state law on the original property acquisition records of DOE (and its predecessor agencies), which will notify anyone searching ORR property records that certain areas of ETTP Zone 2 are contaminated. A survey plat will be prepared for the zoning notices. In accordance with DOE Order 5400.5(IV)(6)(c), controls and appropriate radiological safety measures will be used to prevent disturbance of the residual radioactive material where necessary. For the transfer or release of property from DOE radiological control, authorized limits must ensure that doses to the public from all sources are less than the primary dose limit, in DOE Order 5400.5 (see "chemical-specific ARARs/TBCs") and the authorized limits must be a fraction (1/4) or less of the primary dose. An existing program for excavation/penetration permits will be updated and utilized to limit or prohibit excavation activities in all residual contamination areas. In addition to these administrative controls, access controls will be put in place around the K-1070-C/D Burial Ground until there are no longer any security concerns with this area. These access controls include a fence and daily security surveillance. These controls are not needed to protect against environmental contamination.

Transportation. The requirements for the transportation of materials on public roads, as listed in Table B.3, are legally applicable and must be fully complied with (i.e., both administrative and substantive portions) for off-site transport. They are designed to protect the public and thus, are not relevant and appropriate to on-site transfer on DOE-controlled roads not accessible to the general public. Any wastes that are transferred off-site and transported along non-DOE-controlled roads must meet the U.S. Department of Transportation (DOT) requirements (49 CFR 171-179) for hazardous materials, as well as the specific requirements for the type of waste (e.g., RCRA, PCB, transuranic, LLW, or mixed). These include packaging, labeling, marking, manifesting, and placarding requirements for the specific waste type. EPA and TDEC regulations governing generators and transporters of hazardous waste are found under 40 CFR 262-263 and Rules of the TDEC Chap. 1200-1-11-.03. Pre-transport requirements under these regulations reference the DOT regulations under 49 CFR 172-173, 178, and 179. DOE Order 435.1 also governs the off-site transport of radioactive waste. Finally, DOE Order 460.1B mandates that on-site transfers of hazardous materials comply with 49 CFR 171-180 or a site- or facility-specific approved Transportation

Safety Document that describes the methodology and compliance process to meet equivalent safety for any deviation from the Hazardous Material Regulations (49 CFR 171-180).

CERCLA Sect. 121(d)(3) provides that the off-site transfer of any hazardous substance, pollutant, or contaminant generated during CERCLA response actions be to a treatment, storage, or disposal (TSD) facility that is in compliance with applicable federal and state laws and has been approved by EPA for acceptance of CERCLA waste ("Off-Site Rule" at 40 CFR 300.440 ct seq.). Accordingly, DOE will verify with the appropriate EPA regional contact that any off-site TSD facility to which waste is sent is acceptable for the receipt of CERCLA wastes prior to transfer. As discussed under "Removal of Contaminated Soil," disposal at the EMWMF, the Y-12 Sanitary Landfill, or other on-ORR disposal facility would be considered on-site disposal.

B.4 REFERENCE

Awl, D. J., et al. 1996. *Survey of Protected Vascular Plants on the Oak Ridge Reservation, Oak Ridge, Tennessee*, ES/ER-TM-194, Lockheed Martin Energy Systems, Inc.. Oak Ridge, TN.

Table B.1. Chemical-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee

Contaminants/medium	Requirements	Prerequisites	Citation(s)
Release of radionuclides into the environment	Exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Release of radionuclides to the environment from an active NRC-licensed operation – **relevant and appropriate**	10 *CFR* 20.1301(a)(1) DOE Order 5400.5 (TBC)
	Shall use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve doses to members of the public that are ALARA.	Release of radionuclides to the environment from an active NRC-licensed operation – **relevant and appropriate**	10 *CFR* 20.1101(b) DOE Order 5400.5 (TBC)
Residual PCB-contaminated soil	Risk-based cleanup levels may be established in coordination with the EPA Regional Administrator. Such cleanup levels must not pose an unreasonable risk of injury to human health and the environment.	Soil contaminated by a release, spill, or disposal of material after July 2, 1979, where the PCB concentration in the original material was ≥50 ppm – **applicable**	40 *CFR* 761.61(c)
Soil impacted by previous UST releases	Remediate impacted soil and/or groundwater to meet the cleanup levels listed in Appendices 4 and 5 to TDEC 1200-1-15-.06(7)(e) or background levels or develop a risk-based site-specific standard.	Release of petroleum products that pose a current or potential threat to human health or the environment from USTs that were previously closed and/or removed from the ground – **applicable**	Rules of the TDEC Chap. 1200-1-15-.07(4)
Residual radioactively-contaminated soil	Must achieve cleanup levels of equal to or less than 5 pCi/g above background for radium-226 and thorium-232 (and their daughter products) averaged over the first 15 cm of soil and 15 pCi/g averaged over 15-cm-thick layers of soil below the first 15 cm.	Residual radioactive material in soil – **relevant and appropriate**	40 CFR 192.12
	Guidelines for residual concentrations of radionuclides in soil shall be derived from the basic dose limit using an environmental pathway analysis.	Residual radioactive material in soil – **TBC**	DOE Order 5400.5(IV)(4)(a)
	Must achieve cleanup levels of equal to or less than 5 pCi/g above background for radium-226, radium-228, thorium-230, and thorium-232 averaged over the first 15 cm of soil and 15 pCi/g averaged over 15-cm-thick layers of soil below the first 15 cm.		DOE Order 5400.5(IV)(4)(a)(2)

ALARA = as low as reasonably achievable.
ARAR = applicable or relevant and appropriate requirement.
CFR = *Code of Federal Regulations.*
DOE = U. S. Department of Energy.
EDE = effective dose equivalent.
EPA = U. S. Environmental Protection Agency.
ETTP = East Tennessee Technology Park.
NRC = U. S. Nuclear Regulatory Commission.
PCB = polychlorinated biphenyl.
TBC = to be considered [guidance].
TDEC = Tennessee Department of Environment and Conservation.
UST = underground storage tank.

Table B.2. Location-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
	Wetlands		
Presence of wetlands as defined in 10 *CFR* 1022.4(v)	Activities by DOE that impact or are taken within wetlands shall avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands. Measures shall be taken to mitigate adverse effects of actions in wetlands including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas.	Actions that involve potential impacts to, or take place within, wetlands – **applicable**	10 *CFR* 1022.3(a) 10 *CFR* 1022.12(a)(3)
	Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.		10 *CFR* 1022.3(b)(5) and (6)
	Potential effects of any new construction in wetlands shall be evaluated. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands.		10 *CFR* 1022.3(c) and (d)
Presence of jurisdictional wetlands as defined in 40 *CFR* 230.3, 33 *CFR* 328.3(a), and 33 *CFR* 328.4	The discharge of dredged or fill material into Waters of the United States, including jurisdictional (adjacent) wetlands, is prohibited if there is a practical alternative that would have less adverse impact. No discharge shall be permitted that results in violation of State water quality standards, violates any toxic effluent standard, and/or jeopardizes an endangered species or its critical habitat. No discharge will be permitted that will cause significant degradation of Waters of the United States. No discharge is permitted unless mitigation measures have been taken in accordance with 40 *CFR* 230 Subpart H. Compensatory mitigation for loss of wetlands shall be provided for wetlands < 0.25 acre. Compensatory mitigation shall be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation.	Actions that involve the discharge of dredged or fill material into Waters of the United States, including jurisdictional (adjacent) wetlands – **applicable**	10 *CFR* 230.10(a), (b), (c) and (d) 40 *CFR* 230 Subpart H

Table B.2. Location-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Presence of wetlands as defined under Rules of the TDEC Chap. 1200-4-7-.03	Mitigation must be provided where any activity would result in permanent loss of wetlands. For isolated wetlands of less than 0.25 acre, compensatory mitigation is not required.	Activity that would cause loss of wetlands of > 0.25 acre in Zone 2 – **applicable**	Rules of the TDEC Chap. 1200-4-7-.04 (7)(b)
Presence of minor isolated wetlands of < 0.25 acre	Alteration of minor isolated wetlands of < 0.25 acre must meet certain requirements as follows: ∘ the alteration shall not adversely affect adjacent wetlands; ∘ excavation and fill shall be kept to a minimum, and all excess material shall be hauled upland; ∘ clearing, grubbing, or other disturbance of areas immediately adjacent to Waters of the State shall be limited to the minimum necessary to accomplish the proposed activity. Unnecessary vegetation removal is prohibited, and disturbed areas shall be stabilized and re-vegetated as soon as practicable; ∘ any material discharged into wetlands shall be free of contaminants, including toxic pollutants and hazardous substances; ∘ erosion and sedimentation control measures must be maintained throughout the construction period, and; ∘ upon achievement of final grade, all disturbed areas shall be stabilized and revegetated within 30 days.	Alteration of minor wetlands – **TBC**	TDEC general permit requirements for minor wetlands alteration
Presence of floodplain as defined in 10 *CFR* 1022.4(i)	Activities by DOE that are taken within a floodplain shall avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains. Measures shall be taken to mitigate adverse effects of actions in a floodplain, including measures to reduce the risk of flood loss, minimize the impact of floods on human safety and health, and restore/preserve the beneficial values of the floodplain. DOE structures constructed in a floodplain shall meet the standards and criteria set forth in the regulations promulgated by the Federal Insurance Administration pursuant to the National Flood Insurance Act of 1968.	Federal actions that involve potential impacts to, or take place within, floodplains – **applicable**	10 *CFR* 1022.3(a)

Table B.2. Location-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
	The potential effects of any action taken in a floodplain shall be evaluated (such as including loss of floodplain/floodway storage capacity). Any new construction shall implement actions that mitigate floodplain impacts (such as provision of compensatory floodplain/floodway storage capacity and preventing the increase in flood height or velocity).		10 *CFR* 1022.3(c) and (d)
	Design or modify selected alternatives to minimize harm to or within floodplains and restore and preserve floodplain values.		10 *CFR* 1022.5(b)
Aquatic resources			
Waters of the State as defined in *TCA* 69-3-103(33)	Must comply with the substantive requirements of the ARAP for erosion and sediment control to prevent pollution. Pollution control requirements include, but are not limited to, the following: • limit clearing, grubbing, and other disturbances in areas in, or immediately adjacent to, Waters of the State to the minimum necessary to accomplish the proposed activity; • unnecessary vegetation removal is prohibited, and all disturbed areas must be properly stabilized and revegetated as soon as practicable; • limit excavation, dredging, bank reshaping, or grading to the minimum necessary to install authorized structures, accommodate stabilization, or prepare banks for revegetation; • maintain the erosion and sedimentation control measures throughout the construction period; • upon achievement of a final grade, stabilize and revegetate, within 30 days, all disturbed areas by sodding, seeding, or mulching, or using appropriate native riparian species; and • adverse impacts to threatened or endangered species are prohibited.	Action potentially altering the properties of any Waters of the State – **applicable**	*TCA* 69-3-108(b)(1)(j) TDEC ARAP Program General Requirements **(TBC)**

Table B.2. Location-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Location characteristic(s)	Requirement(s)	Prerequisite	Citation(s)
Location encompassing aquatic ecosystem as defined in 40 *CFR* 230.3(c)	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact.	Action that involves discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 *CFR* 230.10(a)
	No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 *CFR* 230.70 *et seq.* are taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.		40 *CFR* 230.10(d)
	Endangered, threatened, or rare species		
Presence of Tennessee-listed endangered or rare plant species as listed in Rules of the TDEC Chap. 0400-6-2.04	May not knowingly uproot, dig, take, remove, damage or destroy, possess, or otherwise disturb for any purpose any endangered species.	Action impacting rare plant species including, but not limited to, federally listed endangered species – **applicable**	*TCA* 70-8-309 TWRCP 94-16(II)(1)(a) TWRCP 94-17(II)
	Cultural resources		
Presence of archaeological resources	May not excavate, remove, damage, or otherwise alter or deface such resource unless by permit or exception.	Action that would impact archaeological resources on public lands – **applicable**	43 *CFR* 7.4(a)
	Must protect any such archaeological resources if discovered.	Excavation activities that inadvertently discover archaeological resources – **applicable**	43 *CFR* 7.5(b)(1)
Presence of human remains, funerary objects, sacred objects, or objects of cultural patrimony for Native Americans	Must stop activities in the area of the discovery and take reasonable effort to secure and protect the objects discovered.	Excavation activities that inadvertently discover such resources on federal lands or under federal control – **applicable**	43 *CFR* 10.4(c) and (d)
Presence of a cemetery	Intentional desecration of a place of burial is prohibited.	Action that would alter or destroy property in a cemetery – **applicable**	*TCA* 39-17-311

ARAP = Aquatic Resource Alteration Permit.
ARAR = applicable or relevant and appropriate requirement.
CFR = Code of Federal Regulations.
DOE = U. S. Department of Energy.
ETTP = East Tennessee Technology Park.
TBC = to be considered.
TCA =Tennessee Code Annotated.
TDEC =Tennessee Department of Environment and Conservation.
TWRCP = Tennessee Wildlife Resources Commission Proclamation.

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee

Action	Requirements	Prerequisite	Citation(s)
General construction standards–site preparation, excavation, drilling, trenching, etc. activities			
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following:	Fugitive emissions from demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land—**applicable**	Rules of the TDEC Chap. 1200-3-8-.01(1)
	• use, where possible, of water or chemicals for control of dust, and		Rules of the TDEC Chap. 1200-3-8-.01(1)(a)
	• application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces which can create airborne dusts;		Rules of the TDEC Chap. 1200-3-8-.01(1)(b)
	Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 minutes/hour or 20 minutes/day beyond property boundary lines on which emission originates		Rules of the TDEC Chap. 1200-3-8-.01(2)
Activities causing radionuclide emissions	Shall not exceed those amounts that would cause any member of the public to receive an EDE of 10 mrem per year	Radionuclide emissions from point sources, as well as diffuse or fugitive emissions, at a DOE facility—**applicable**	40 *CFR* 61.92 Rules of the TDEC Chap. 1200-3-11-.08(6)
Activities causing storm water runoff *(e.g., clearing, grading, excavation)*	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of *General Permit No. TNR10-0000, Appendix F,* to ensure that storm water discharge:	Dewatering or storm water runoff discharges from land disturbed by construction activity—disturbance of ≥1 acre total—**applicable**; <5 acres—**relevant and appropriate**	*TCA* 69-3-108(j) Rules of the TDEC Chap. 1200-4-10-.03(2)(i)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	◦ does not violate water quality criteria as stated in TDEC 1200-4-3-.03 including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of Waters of the State for any of the designated uses for that water body by TDEC 1200-4-4;	Storm water discharges from construction activities—**TBC**	*General Permit No. TNR10-0000* Part III D.2.a
	◦ does not contain distinctly visible floating scum, oil, or other matter;		*General Permit No. TNR10-0000* Part III D.2.b
	◦ does not cause an objectionable color contrast in the receiving stream; and		*General Permit No. TNR10-0000* Part III D.2.c
	◦ results in no materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream		*General Permit No. TNR10-0000* Part III D.2.d
	Removal of contaminated soils and debris		
Removal of radionuclide-contaminated soils and debris *(e.g., foundation slabs)*	Guidelines for residual concentrations of radionuclides in soil and debris shall be derived from the basic dose limit using an environmental pathway analysis. Must also achieve generic guidelines in 5400.5(IV)(4)(a)(2) for radium-226, radium-228, thorium-230, and thorium-232.	Residual radioactive material in soil and debris—**TBC** for determining which soils/debris need to be removed	DOE Order 5400.5(IV)(4)(a)
	Must achieve cleanup levels of equal to or less than 5 pCi/g above background for radium-226 and thorium-232 (and their daughter products) averaged over the first 15 cm of soil and 15 pCi/g averaged over 15-cm-thick layers of soil below the first 15 cm.	Residual radioactive material in soil—**relevant and appropriate**	40 *CFR* 192.12

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Removal of PCB-contaminated soil	Risk-based cleanup levels, other than those specified under 40 *CFR* 761.61(a), may be established in coordination with the EPA Regional Administrator. Such clean-up levels must not pose an unreasonable risk of injury to human health and the environment.	Soil contaminated by a release, spill, or disposal of material after July 2, 1979, where the PCB concentration in the original material was ≥ 50 ppm—**applicable** for determining which soils need to be removed	40 *CFR* 761.61(c)
Waste generation, characterization, segregation, and storage—excavated soils, buried wastes, slabs, and subsurface structures, and secondary wastes			
Characterization of solid waste *(all primary and secondary wastes)*	Must determine if solid waste is hazardous waste or if waste is excluded under 40 *CFR* 261.4(b); and	Generation of solid waste as defined in 40 *CFR* 261.2 and which is not excluded under 40 *CFR* 261.4(a)—**applicable**	40 *CFR* 262.11(a) Rules of the TDEC Chap. 1200-1-11-.03(1)(b)(1)
	Must determine if waste is listed under 40 *CFR* Part 261; or		40 *CFR* 262.11(b) Rules of the TDEC Chap. 1200-1-11-.03(1)(b)(2)
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used, and must manage waste in accordance with 40 *CFR* 260-272 if determined to be hazardous waste		40 *CFR* 262.11(c) Rules of the TDEC 1200-1-11-.03(1)(b)(3)
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste	Generation of solid waste which is determined to be hazardous—**applicable**	40 *CFR* 262.11(d); Rules of the TDEC Chap. 1200-1-11-.03(1)(b)(4)
Characterization of hazardous waste ***(all primary and secondary wastes)***	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 *CFR* 264 and 268	Generation of RCRA-hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 264.13(a)(1) Rules of the TDEC Chap. 1200-1-11-.06(2)(d)(1)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Must determine the underlying hazardous constituents [as defined in 40 *CFR* 268.2(i)] in the waste	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42, Table 1) for storage, treatment, or disposal—**applicable**	40 *CFR* 268.9(a) Rules of the TDEC Chap. 1200-1-11-.10(1)(i)(1)
	Must determine if the waste is restricted from land disposal under 40 *CFR* 268 *et seq.* by testing in accordance with prescribed methods or use of generator knowledge of waste		40 *CFR* 268.7 Rules of the TDEC Chap. 1200-1-11-.10(1)(g)(1)(i)
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* 268.40 *et. seq.*		40 *CFR* 268.9(a) Rules of the TDEC Chap. 1200-1-11-.10(1)(i)(1)
Temporary storage of hazardous waste in containers *(e.g., **lead-contaminated debris**)*	A generator may accumulate hazardous waste at the facility provided that	Accumulation of RCRA hazardous waste on-site (as defined in 40 *CFR* 260.10)—**applicable**	40 *CFR* 262.34(a); Rules of the TDEC Chap. 1200-1-11-.03(4)(e)
	° waste is placed in containers that comply with 40 *CFR* 265.171–173, and		40 *CFR* 262.34(a)(1)(i); Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(ii)(I)
	° the date upon which accumulation begins is clearly marked and visible for inspection on each container		40 *CFR* 262.34(a)(2); Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(ii)
	° the container is marked with the words "hazardous waste," or		40 *CFR* 262.34(a)(3); Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(2)(iv)
	° the container may be marked with other words that identify the contents	Accumulation of 55 gal or less of RCRA hazardous waste at or near any point of generation—**applicable**	40 *CFR* 262.34(c)(1); Rules of the TDEC Chap. 1200-1-11-.03(4)(e)(5)(i)(II)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Use and management of hazardous waste in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition	Storage of RCRA hazardous waste in containers—**applicable**	40 *CFR* 264.171; Rules of the TDEC Chap. 1200-1-11-.05(9)(b)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired		40 *CFR* 264.172; Rules of the TDEC Chap. 1200-1-11-.05(9)(c)
	Keep container closed during storage, except to add/remove waste		40 *CFR* 264.173(a); Rules of the TDEC Chap. 1200-1-11-.05(9)(d)(1)
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak		40 *CFR* 264.173(b); Rules of the TDEC Chap. 1200-1-11-.05(9)(d)(2)
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 *CFR* 264.175(b)	Storage in containers of RCRA-hazardous waste with free liquids—**applicable**	40 *CFR* 264.175(a); Rules of the TDEC, Chap. 1200-1-11-.06(9)(f)(1)
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid	Storage in containers of RCRA-hazardous waste that does not contain free liquids—**applicable**	40 *CFR* 264.175(c); Rules of the TDEC Chap. 1200-1-11-.06(9)(f)(3)
Characterization and management of universal wastes (*e.g., buried batteries, pesticides, thermostats*)	A large quantity handler of universal waste must manage universal waste in accordance with 40 *CFR* 273 (TDEC 1200-1-11-.12) in a way that prevents releases of any universal waste or component of a universal waste to the environment.	Generation of universal waste [as defined in TDEC 1200-1-11-.12(1)(a)] for disposal—**applicable**	40 *CFR* 273 Rules of the TDEC Chap. 1200-1-11-.12
Characterization of LLW (*e.g., contaminated PPE, buried waste and debris, basements, foundation slabs)*	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility	Generation of LLW for storage or disposal at a DOE facility—**TBC**	DOE M 435.1-1(IV)(I)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1(IV)(I)(2)(a)
	∘ physical and chemical characteristics;		DOE M 435.1-1(IV)(I)(2)(a)
	∘ volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1(IV)(I)(2)(b)
	∘ weight of the container and contents;		DOE M 435.1-1(IV)(I)(2)(c)
	∘ identities, activities, and concentration of major radionuclides;		DOE M 435.1-1(IV)(I)(2)(d)
	∘ characterization date;		DOE M 435.1-1(IV)(I)(2)(e)
	∘ generating source; and		DOE M 435.1-1(IV)(I)(2)(f)
	∘ any other information that may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives		DOE M 435.1-1(IV)(I)(2)(g)
Temporary storage of LLW *(e.g., soil, contaminated PPE, basement and foundation materials, debris)*	Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water	Management of LLW at a DOE facility—**TBC**	DOE M 435.1-1 (IV)(N)(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage		DOE M 435.1-1 (IV)(N)(3)
	Shall be managed to identify and segregate LLW from mixed waste		DOE M 435.1-1 (IV)(N)(6)
Packaging of solid LLW *(e.g., soil, contaminated PPE, equipment, scrap metal, surface feature materials, debris)*	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container	Storage of LLW in containers at a DOE facility—**TBC**	DOE M 435.1-1(IV)(L)(1)(a)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container		DOE M 435.1-1(IV)(L)(1)(b)
	Containers shall be marked such that their contents can be identified		DOE M 435.1-1(IV)(L)(1)(c)
Removal of RACM	Procedures for asbestos emission control per 40 *CFR* 61.145(c)(1-10) shall be followed, as appropriate	Removal of debris containing RACM exceeding the volume requirements of 40 *CFR* 61.145(a)(1)—**applicable**	40 *CFR* 61.145(c) Rules of the TDEC Chap. 1200-3-11-.02(2)(d)(3)
Management of asbestos-containing waste prior to disposal *(e.g., buried pipelines)*	Discharge no visible emissions to the outside air, or use one of the emission control and waste treatment methods specified in paragraphs (a)(1) through (a)(4) of 40 *CFR* 61.150	Collection, processing, packaging or transporting of any asbestos-containing waste material generated by demolition activities—**applicable**	40 *CFR* 61.150(a) Rules of the TDEC Chap. 1200-3-11-.02(2)(j)(1)
Management of PCB waste *(e.g., contaminated PPE, basement and foundation materials, soil, sludges, debris)*	Any person storing or disposing of PCB waste must do so in accordance with 40 *CFR* 761, Subpart D	Generation of waste containing PCBs at concentrations ≥50 ppm—**applicable**	40 *CFR* 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found	Generation of PCB remediation waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.61
Management of PCB/radioactive waste *(e.g., contaminated equipment, soils, debris, oils, etc.)*	Any person storing such waste must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 *CFR* 761.65(a)(1), (b)(1)(ii) and (c)(6)(i)	Generation for disposal of PCB/ radioactive waste with ≥ 50 ppm PCBs—**applicable**	40 *CFR* 761.50(b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties		40 *CFR* 761.50(b)(7)(ii)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	If, after taking into account only the PCB properties in the waste, the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as municipal or non-municipal non-hazardous waste landfill [e.g., PCB bulk product waste under 40 *CFR* 761.62(b)(1)], the person may dispose of such waste without regard to the PCBs, based on its radioactive properties alone in accordance with applicable requirements		
Temporary storage of PCB waste *(e.g., contaminated PPE, debris, soils, sludges)*	Container(s) shall be marked as illustrated in 40 *CFR* 761.45(a)	Storage of PCBs and PCB Items at concentrations 50 ppm for disposal—**applicable**	40 *CFR* 761.65(a)(1)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10)		40 *CFR* 761.65(c)(3)
	Any leaking PCB Items and their contents shall be transferred immediately to a properly marked non-leaking container(s).		40 *CFR* 761.65(c)(5)
	Container(s) shall be in accordance with requirements set forth in DOT HMR at 49 *CFR* 171-180		40 *CFR* 761.65(c)(6)
	The date shall be recorded when PCB items are removed from service, and the storage shall be managed such that PCB items can be located by this date. (Note: Date should be marked on the container.)	PCB items (includes PCB wastes) removed from service for disposal—**applicable**	40 *CFR* 761.65(c)(8)
Storage of PCB/ radioactive waste in containers *(e.g., PCB liquids, PCB-contaminated articles, PCB bulk-product wastes)*	For liquid wastes, containers must be non-leaking	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performances standards—**applicable**	40 *CFR* 761.65(c)(6)(i)(A)
	For non-liquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 *CFR* 761.65(b)(1)(ii)		40 *CFR* 761.65(c)(6)(i)(B)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	For both liquid and non-liquid wastes, containers must meet all regulations and requirements pertaining to nuclear criticality safety		40 *CFR* 761.65(c)(6)(i)(C)
Storage of PCB waste and/or PCB/radioactive waste in a non-RCRA regulated unit	Storage facility must have or be	Storage of PCBs and PCB items at concentrations ≥50 ppm for disposal— **applicable**	40 *CFR* 761.65(b)(1)
	• adequate roof and walls to prevent rainwater from reaching stored PCBs and PCB items;		40 *CFR* 761.65(b)(1)(i)
	• adequate floor that has continuous curbing with a minimum 6-in.-high curb. Floor and curb must provide a containment volume equal to at least two times the internal volume of the largest PCB article or container or 25% of the internal volume of all articles or containers stored there, whichever is greater. *Note:* 6-in. minimum curbing not required for area storing PCB/radioactive waste;	Storage of PCB/radioactive waste (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.65(b)(1)(ii)
	• no drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from curbed area;		40 *CFR* 761.65(b)(1)(iii)
	• floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, nonporous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* 761.65(b)(1)(iv)
	• not located at a site that is below 100-year floodwater elevation.		40 *CFR* 761.65(b)(1)(v)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10):		40 *CFR* 761.65(c)(3)
	• floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, nonporous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* 761.65(b)(1)(iv)
	• not located at a site that is below 100-year floodwater elevation.		40 *CFR* 761.65(b)(1)(v)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10):		40 *CFR* 761.65(c)(3)
	° floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, nonporous surface that prevents or minimizes penetration of PCBs; and		40 *CFR* 761.65(b)(1)(iv)
	° not located at a site that is below 100-year flood water elevation.		40 *CFR* 761.65(b)(1)(v)
	Storage area must be properly marked as required by 40 *CFR* 761.40(a)(10)		40 *CFR* 761.65(c)(3)
Treatment/disposal of waste—excavated soils, buried waste, slabs, and subsurface structures, and secondary wastes			
Disposal of RCRA-hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal	Land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA waste—**applicable**	40 *CFR* 268.40(a) Rules of the TDEC Chap. 1200-1-11-.10(3)(a)
	May be land disposed if it meets the requirements in the table "Alternative Treatment Standards for Hazardous Debris" at 40 *CFR* 268.45 before land disposal or is treated to the waste-specific treatment standard provided in 40 *CFR* 268.40 for the waste contaminating the debris	Land disposal, as defined in 40 *CFR* 268.2, of restricted RCRA-hazardous debris—**applicable**	40 *CFR* 268.45(a) Rules of the TDEC Chap. 1200-1-11-.10(3) (f)(1)
	Must be treated according to the alternative treatment standards of 40 *CFR* 268.49(c) or according to the UTSs specified in 40 *CFR* 268.48 applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal	Land disposal, as defined in 40 *CFR* 268.2, of restricted hazardous soils—**applicable**	40 *CFR* 268.49(b) Rules of the TDEC Chap. 1200-1-11-10(3)(j)(2)
	Are not prohibited if the wastes no longer exhibit a characteristic at the point of land disposal, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40, or are D003 reactive cyanide	Land disposal of restricted RCRA characteristically hazardous wastes—**applicable**	40 *CFR* 268.1(c)(4)(iv) Rules of the TDEC Chap. 1200-1-11-.10(1) (a)(3)(iv)(IV)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Disposal of RCRA waste waters	Are not prohibited, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 268.40, or are D003 reactive cyanide	Restricted RCRA characteristic hazardous wastes managed in a wastewater treatment system which is CWA NPDES permitted—**applicable**	40 *CFR* 268.1(c)(4)(iv); Rules of the TDEC Chap. 1200-1-11-10(1)(a)(3)(iv)(IV)
Packaging of LLW for disposal *(e.g., contaminated PPE, foundation slab debris, excavated soils)*	Must have structural stability either by processing the waste or placing the waste in a container or structure that provides stability after disposal	Generation of LLW for disposal at a LLW disposal facility—**relevant and appropriate**	Rules of the TDEC Chap. 1200-2-11-.17(7)(b)(1)
	Void spaces within the waste and between the waste, and its package must be reduced to the extent practicable		Rules of the TDEC Chap. 1200-2-11-.17(7)(b)(3)
Treatment of LLW	Treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet the performance objectives of the disposal facility	Generation of LLW for disposal at a LLW disposal facility—**TBC**	DOE M 435.1-1(IV)(O)
Disposal of solid LLW *(e.g., buried debris, pipelines, soil, excavated wastes)*	LLW shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility	Generation of LLW for disposal at a DOE facility—**TBC**	DOE M 435.1-1(IV)(J)(2)
Disposal of asbestos-containing waste material *(buried pipeline debris)*	Shall be deposited as soon as practicable at: • an approved waste disposal site operated in accordance with Sect. 61.154, or • an EPA-approved site that converts RACM and asbestos-containing waste material into non-asbestos (asbestos-free) material according to the provisions of 40 *CFR* 61.155	Asbestos-containing waste material or RACM (except Category I nonfriable asbestos-containing material) from demolition activities—**applicable**	40 *CFR* 61.150(b) Rules of the TDEC Chap. 1200-3-11-.02(2)(j)(2)
Disposal of PCB capacitor(s) *(if excavated from burial grounds)*	Shall comply with all requirements of Sect. 761.60 unless it is known from label or nameplate information, manufacturer's literature, or chemical analysis that the capacitor does not contain PCBs	Generation of PCB Capacitors with ≥50 PCBs for disposal—**applicable**	40 *CFR* 761.60(b)(2)(i)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	May dispose of in a municipal solid waste landfill unless subject to 40 *CFR* 761.60(b)(2)(iv)	Generation for disposal of intact, non-leaking PCB small capacitors (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.60(b)(2)(ii)
	Shall dispose of in accordance with either of the following: ° disposal in an incinerator that complies with 40 *CFR* 761.70, or ° disposal in a chemical waste landfill that complies with 40 *CFR* 761.75.	PCB large capacitor which contains ≥500 ppm PCBs—**applicable**	40 *CFR* 761.60(b)(2)(iii)
	Shall dispose of in one of the following disposal facilities approved under this part: ° incinerator under 40 *CFR* 761.70, ° chemical waste landfill under 40 *CFR* 761.75, ° high-efficiency boiler under 40 *CFR* 761.70, or ° scrap metal recovery oven and smelter under 40 *CFR* 761.71	Disposal of large capacitors that contain ≥50 ppm but <500 ppm PCBs—**applicable**	40 *CFR* 761.60(b)(4)(ii)
Disposal of decontamination waste and residues	Such wastes shall be disposed of at their existing PCB concentrations unless otherwise specified in 40 *CFR* 761.79(g)(1-6)	PCB decontamination waste and residues—**applicable**	40 *CFR* 761.79(g)
Disposal of PCB-contaminated precipitation, condensation, leachate, or load separation	May be disposed in a chemical waste landfill which complies with 40 *CFR* 761.75 if:	PCB liquids at concentrations ≥50 ppm from incidental sources and associated with PCB articles or non-liquid PCB wastes—**applicable**	40 *CFR* 761.60(a)(3)
	° disposal does not violate 40 *CFR* 268.32(a) or 268.42(a)(1), and		40 *CFR* 761.60(a)(3)(i)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	• liquids do not exceed 500 ppm PCB and are not an ignitable waste as described in 40 *CFR* 761.75(b)(8)(iii).		40 *CFR* 761.60(a)(3)(ii)
Disposal of PCB-contaminated porous surfaces *(e.g., concrete slabs or debris)*	Shall be disposed on-site or off-site as bulk PCB-remediation waste according to 40 *CFR* 761.61(a)(5)(i) or decontaminated for use according to 40 *CFR* 761.79(b)(4)	PCB remediation waste porous surfaces (as defined in 40 *CFR* 761.3)—**applicable**	40 *CFR* 761.61(a)(5)(iii)
Disposal of PCB-contaminated nonporous surfaces off-site	Shall be disposed of in accordance with 40 *CFR* 761.61(a)(5)(i)(B)(3)(ii) [sic] 40 *CFR* 761.61(a)(5)(i)(B)(2)(ii)	PCB remediation waste nonporous surfaces (as defined in 40 *CFR* 761.3) having surface concentrations <100 µg/100 cm^2—**applicable**	40 *CFR* 761.61(a)(5)(ii)(B)(1)
	Metal surfaces may be thermally decontaminated in accordance with 40 *CFR* 761.79(c)(6)(i)		
	Shall be disposed of in accordance with 40 *CFR* 761.61(a)(5)(i)(B)(3)(iii) [sic 40 *CFR* 761.61(a)(5)(i)(B)(2)(iii)]	PCB remediation waste nonporous surfaces having surface concentrations ≥100 µg/100 cm^2—**applicable**	40 *CFR* 761.61 (a)(5)(ii)(B)(2)
Performance-based disposal of PCB remediation waste *(e.g., PCB-contaminated basement or foundation materials or excavated waste)*	May dispose of by one of the following methods: • in a high-temperature incinerator approved under 40 *CFR* 761.70(b), • by an alternate disposal method approved under 40 *CFR* 761.60(e), • in a chemical waste landfill approved under 40 *CFR* 761.75, • in a facility with a coordinated approval issued under 40 *CFR* 761.77, or • through decontamination in accordance with 40 *CFR* 761.79.	Disposal of non-liquid PCB remediation waste (including porous and non-porous surfaces contaminated from a leaking PCB transformer)—**applicable**	40 *CFR* 761.61(b)(2) 40 *CFR* 761.61(b)(2)(i)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Disposal of PCB cleanup wastes *(e.g., contaminated PPE, nonliquid cleaning materials)*	Shall be disposed of either: ∘ in a facility permitted, licensed, or registered by a state to manage municipal solid waste under 40 *CFR* 258 or nonmunicipal, nonhazardous waste subject to 40 *CFR* 257.5 thru 257.30; or ∘ in a RCRA Subtitle C landfill permitted by a state to accept PCB waste; or ∘ in an approved PCB disposal facility; or ∘ through decontamination under 40 *CFR* 761.79(b) or (c).	Generation of nonliquid PCBs at any concentration during and from the cleanup of PCB remediation waste—**applicable**	40 *CFR* 761.61(a)(5)(v)(A)
Disposal of PCB cleaning solvents, abrasives, and equipment	May be reused after decontamination in accordance with 40 *CFR* 761.79	Generation of PCB wastes from the cleanup of PCB remediation waste—**applicable**	40 *CFR* 761.61(a)(5)(v)(B)
Disposal of PCB remediation waste *(e.g., soils, sludges)*	May dispose by one of the following methods: ∘ in a high-temperature incinerator approved under 40 *CFR* 761.70(b); ∘ by an alternate disposal method approved under 40 *CFR* 761.60(e); ∘ in a chemical waste landfill approved under 40 *CFR* 761.75; ∘ in a facility with a coordinated approval issued under 40 *CFR* 761.77; or ∘ through decontamination in accordance with under 40 *CFR* 761.79.	Disposal of non-liquid PCB remediation waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.61(b)(2) 40 *CFR* 761.61(b)(2)(i) 40 *CFR* 761.61(b)(2)(ii)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Disposal of PCB bulk product waste *(e.g., excavated wastes with PCB painted surfaces)*	May dispose of by one of the following:	Disposal of PCB bulk product waste as defined in 40 *CFR* 761.3—**applicable**	40 *CFR* 761.62(a)
	• in an incinerator approved under 40 *CFR* 761.70;		40 *CFR* 761.62(a)(1)
	• in a chemical waste landfill approved under 40 *CFR* 761.75;		40 *CFR* 761.62(a)(2)
	• in a hazardous waste landfill permitted by EPA under RCRA Sect. 3004 or by authorized state under RCRA Sect. 3006;		40 *CFR* 761.62(a)(3)
	• under alternate disposal approved under 40 *CFR* 761.60(e);		40 *CFR* 761.62(a)(4)
	• in accordance with decontamination provisions of 40 *CFR* 761.79; or		40 *CFR* 761.62(a)(5)
	• in accordance with thermal decontamination provisions of 40 *CFR* 761.79(e)(6) for metal surfaces in contact with PCBs.		40 *CFR* 761.62(a)(6)
Institutional controls—all waste and contaminated soil left in place			
Waste left in place	Institutional controls are required and shall include, at a minimum, deed restrictions for sale and use of property and securing area to prevent human contact with hazardous substances	Hazardous substances left in place that may pose an unreasonable threat to public health, safety, or the environment—**relevant and appropriate**	Rules of the TDEC Chap. 1200-1-13-.08(10)
Radioactive material left in place	A property may be maintained under interim management provided administrative controls are established to protect members of the public	Residual radioactive material above guidelines in inaccessible locations which would be unreasonably costly to remove—**TBC**	DOE Order 5400.5(IV)(6)(c)(1)
	Controls include, but are not limited to, periodic monitoring, appropriate shielding, physical barriers to prevent access, appropriate radiological safety measures during maintenance, or other activities that might disturb the residual radioactive material or cause it to migrate		DOE Order 5400.5(IV)(6)(c)(2)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Uranium- and thorium-bearing waste left in place	Access to a property and use of material should be controlled through appropriate administrative and physical controls, designed to be effective to the extent reasonable for at least 200 years	Long term management of radioactive material at a DOE facility—**TBC**	DOE Order 5400.5(IV)(6)(d)(1)(e)
Transfer of property from DOE control to private sector	For transfer of property or release from DOE radiological control, authorized limits must ensure that doses to the public from all sources are less than the primary dose limit for all sources (100 mrem/year) and the authorized limits must be a fraction (1/4) or less of the primary dose (limit for the public)	Release of property from DOE radiological control—**TBC**	DOE Order 5400.5 Response to questions and guidance concerning DOE 5400.5 Section II.5 and Chapter IV
Survey plat	Must submit to the local zoning authority or the authority with jurisdiction over local land use, a survey plat indicating the location and dimensions of the landfill, with respect to permanently surveyed benchmarks. The plat must contain a note, prominently displayed, which state the owner/ operator obligation to restrict disturbance of the landfill.	Closure of a RCRA landfill—**relevant and appropriate** if potential RCRA hazardous wastes are left in place	40 *CFR* 265.116 Rules of the TDEC Chap. 1200-1-11-.05(7)(g)
Postclosure notices	Must submit to the local zoning authority a record of the location, and assumed type and quantity of wastes disposed of within each cell of the unit	Closure of a RCRA landfill—**relevant and appropriate** if potential RCRA hazardous wastes are left in place	40 *CFR* 265.119(a) Rules of the TDEC Chap. 1200-1-11-.05(7)(j)(1)
	Must record, in accordance with state law, a notation on the deed to the facility property—or on some other legal instrument which is normally examined during a title search—that will in perpetuity notify any potential purchaser of the property that:		40 *CFR* 265.119(b)(1) Rules of the TDEC Chap. 1200-1-11-.05(7)(j)(2)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
	• the land has been used to manage potential hazardous wastes; • its use is restricted; and • the survey plat and record of the location and assumed type and quantity of wastes disposed within each cell of the unit have been filed with the local zoning authority and with the EPA Regional Administrator.		
	Within 60 days of closure record, in accordance with State law, make a notation on the deed to the facility property and on any other instrument that would normally be examined during a title search that: • the land has been used for disposal of asbestos-containing waste; and • the survey plat and record of location and quantity of waste disposed within the site have been filed.	Closure of an inactive ACM disposal site—**relevant and appropriate** if ACM is left in place in burial grounds	40 *CFR* 61.151(e) Rules of the TDEC Chap. 1200-1-11-.02(2)(l)(5)
	Transportation		
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 *CFR* 171–180	Any person who, under contract with a department or agency of the federal government, transports "in commerce," or causes to be transported or shipped, a hazardous material—**applicable**	49 *CFR* 171.1(c)
	Shall comply with 49 CFR 171–180 or the site- or facility-specific Operations or Field Office-approved Transportation Safety Document that describes the methodology and compliance process to meet equivalent safety requirements for any deviation from the HMR.	On-site transfer of hazardous materials—**TBC**	DOE O 460.1B(4)(b)
Transportation of radioactive waste	Shall be packaged and transported in accordance with DOE Order 460.1A and DOE Order 460.2	Shipment of LLW off-site—**TBC**	DOE M435.1-(I)(1)(E)(11)

Table B.3. Action-specific ARARs and TBC guidance for the selected alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)
Transportation of LLW	To the extent practical, the volume of the waste and the number of the shipments shall be minimized	Shipment of LLW off-site—**TBC**	DOE M 435.1-1(IV)(L)(2) DOE M 435.1-1(III)(L)(2)
Transportation of PCB wastes	Must comply with the manifesting provisions at 40 *CFR* 761.207 through 40 *CFR* 761.218	Relinquishment of control over PCB wastes by transporting, or offering for transport—**applicable**	40 *CFR* 761.207 (a)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number	Off-site transportation of RCRA hazardous waste—**applicable** if any wastes are determined to be hazardous	40 *CFR* 262.10(h) Rules of the TDEC Chap. Chap. 1200-1-11-.03(1)(a)(8)
	Must comply with the requirements of 40 *CFR* 263.11–263.31	Transportation of hazardous waste within the United States requiring a manifest—**applicable** if any wastes are determined to be hazardous	40 *CFR* 263.10(a) Rules of the TDEC Chap. 1200-1-11-.04(1)(a)(1)
	A transporter who meets all applicable requirements of 49 *CFR* 171–179 and the requirements of 40 *CFR* 263.11 and 263.31 will be deemed in compliance with 40 *CFR* 263		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 *CFR* 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable** if any wastes are determined to be hazardous	40 *CFR* 262.20(f) Rules of the TDEC Chap. 1200-1-11-.03(3)(a)(6)

ACM = asbestos-containing material
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
DEACT = deactivation
DOE M = *Radioactive Waste Management Manual*
DOT = U.S. Department of Transportation
EDE = effective dose equivalent
ETTP = East Tennessee Technology Park
EPA = U.S. Environmental Protection Agency

Table B.3. Action-specific ARARs and TBC guidance for the preferred alternative, ETTP Zone 2 soils, Oak Ridge, Tennessee (continued)

Action	Requirements	Prerequisite	Citation(s)

DOE = U.S. Department of Energy
HMTA = Hazardous Materials Transportation Act
ID = identification
LLW = low-level (radioactive) waste
NPDES = National Pollutant Discharge Elimination System
PCB = polychlorinated biphenyl
PPE = personal protective equipment
RACM = regulated asbestos-containing material
HMR = Hazardous Materials Regulations
RCRA = Resource Conservation and Recovery Act of 1976
TBC = to be considered (guidance)
TCA = *Tennessee Code Annotated*
TDEC = Tennessee Department of Environment and Conservation
UTS = universal treatment standard
WAC = waste acceptance criteria

APPENDIX C

SOIL REMEDIATION LEVELS FOR GROUNDWATER PROTECTION

CONTENTS

FIGURE

TABLES

ACRONYMS

AP	planar area of soil contamination
AT123D	Analytical Transient 1-, 2-, 3-Dimensional Model
C_{gw}	groundwater concentration
COC	contaminant of concern
CSA	contaminated soil area
CSE	soil exposure concentration
C_w	target groundwater concentration
DOE	U.S. Department of Energy
ETTP	East Tennessee Technology Park
f_i	fraction factor
f_{oc}	organic carbon fraction
K_d	soil-water distribution coefficient
K_{oc}	organic-carbon partition coefficient
K_s	saturated hydraulic conductivity
MCL	maximum contaminant level
ORNL	Oak Ridge National Laboratory
$\wp_p$	percolation rate
RL	remediation level
SESOIL	Seasonal Soil Compartment Model
TOC	total organic carbon
UCL_{95}	95% upper confidence limit of the mean
VOC	volatile organic compound

C.1. INTRODUCTION

Soil that contains sufficiently high levels of soluble contaminants can be a source of contamination to groundwater. One of the remediation goals for soil in this decision is to minimize further contamination of the groundwater by remediating soil or waste that contributes significantly to groundwater contamination at levels that would exceed drinking water maximum contaminant levels (MCLs). ^{237}Np and ^{239}Pu are also being evaluated even though MCLs for these radionuclides are not available. For ^{237}Np and ^{239}Pu, residential preliminary remediation goals (PRGs) will be used in place of MCLs.

The approach to determining which subsurface soil requires remediation uses mathematical models to estimate the amount of contaminants released from soil, their attenuation during migration through the groundwater, and the concentration that would occur in water withdrawn from a groundwater well positioned within the lateral boundary of the contaminated area. The calculation models are similar to those used at the Oak Ridge National Laboratory (ORNL) in the *Record of Decision for Interim Actions in Bethel Valley* (DOE 2002) and at the Y-12 National Security Complex in the *Upper East Fork Poplar Creek Soil and Scrapyard Focused Feasibility Study* (DOE 2003).

Section C.2 presents an overview of the model while Section C.3 presents the screening remediation levels. Section C.4 presents the use of the model for selected sites within Zone 2.

C.2. METHODOLOGY FOR CALCULATING SOIL REMEDIATION LEVELS FOR GROUNDWATER PROTECTION

The process of determining concentrations of groundwater contaminants of concern (COCs) in soil that might require removal involves several steps, as shown in Fig. C.1. The first step is to establish a first approximation of soil contaminant remediation levels for groundwater protection for each area of deep soil or buried waste contamination that contains groundwater COCs. The first approximation of remediation levels for groundwater protection uses the Summers Model (Summers et al. 1980) to estimate contaminant concentrations in groundwater leached from the contaminated soil and rough estimates of the footprint area of the contaminated soil. Screening of soil contaminants against the first approximation is achieved by computing fraction factors for all the COCs and determining whether any of the COCs from a site have the potential to contaminate groundwater above the MCL. If the first approximation indicates that subsurface soil might contaminate groundwater above MCLs, a refined assessment is performed using the Seasonal Soil Compartment Model (SESOIL) and the Analytical Transient 1-, 2-, 3-Dimensional Model (AT123D) to calculate contaminant concentrations in a hypothetical groundwater well located at the downgradient edge of the contaminated soil mass. The refined assessment is used to provide the limiting concentration in soil for each contaminant to minimize impacts to groundwater withdrawn from the hypothetical well. Limiting contaminant concentrations in soil are used to generate contours that are subsequently used to compute the volume of soil that must be remediated at each site.

The general process outlined above is described in more detail in Section C.2.1.

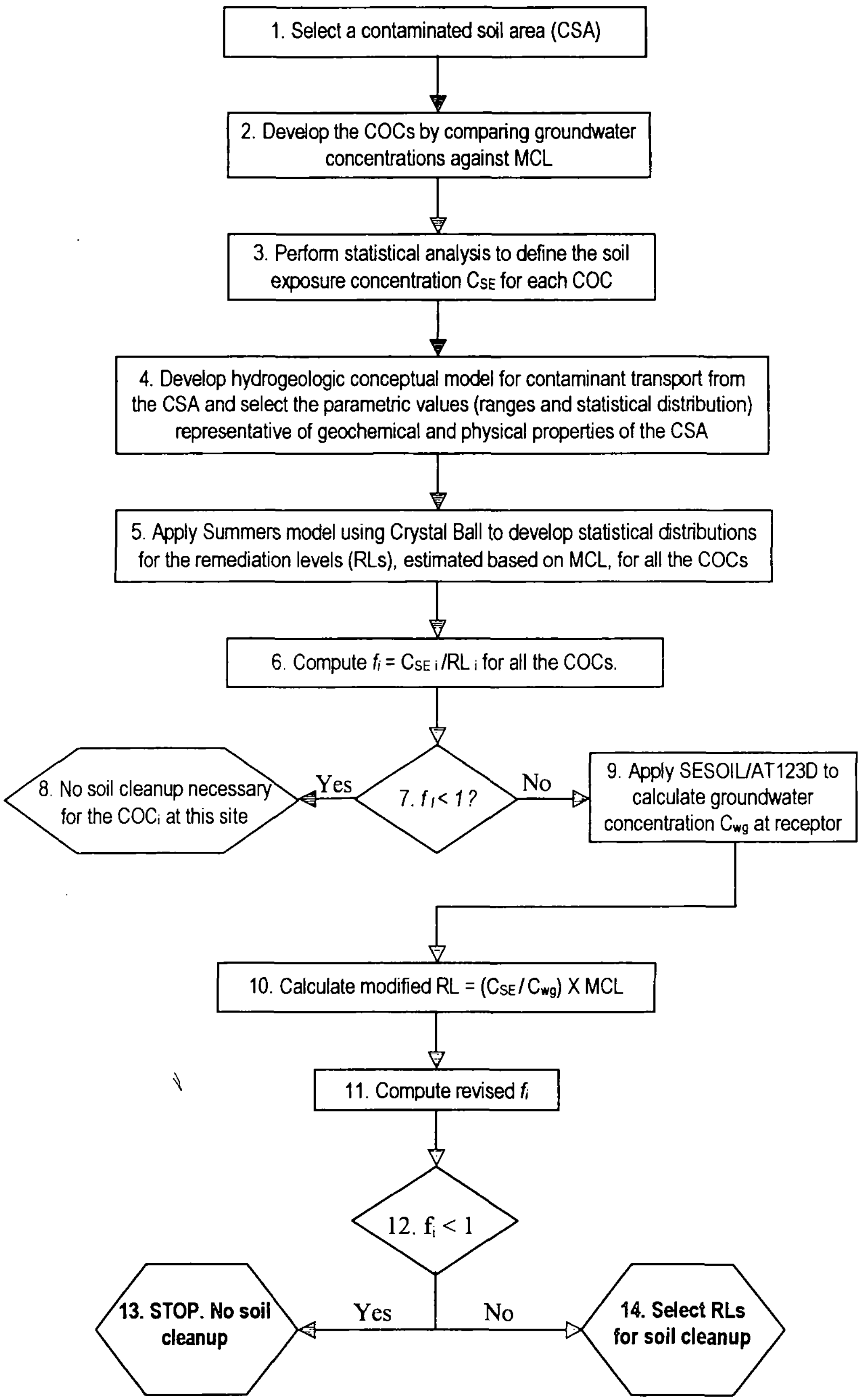

Fig. C.1. ETTP Zone 2 subsurface soil cleanup decision process to minimize impact to groundwater.

C.2.1 FIRST APPROXIMATION OF SOIL REMEDIATION LEVELS FOR GROUNDWATER PROTECTION

1. The first step in determining the requirements for subsurface soil remediation to minimize the impacts to groundwater is to identify the contaminated soil area (CSA) [i.e., known leakage or spill location or other subsurface contaminated soil mass] that has groundwater COCs present. A conceptual site model (CSM) must be developed to define the basis of input parameters required for the contaminant transport modeling.

2. Contaminants to be evaluated are identified based on comparing groundwater concentrations observed beneath Zone 2 with MCLs. Only contaminants that exceeded MCLs more than once in a well are included. If gross alpha and gross beta MCLs are exceeded, it might be necessary to include additional isotopes and their derived MCLs. Additionally, at the request of EPA, ^{237}Np and ^{239}Pu are included as Zone 2 COCs although MCLs are not available for either of these radionuclides. For these two constituents, residential PRGs will be used in place of MCLs. The initial list of contaminants to be considered is presented in Table C.1. From that list, a short list of COCs for a CSA can then be developed by evaluating existing groundwater data and process knowledge. If no wells are appropriately placed to assess groundwater conditions or process knowledge is not specific, all Zone 2 contaminants identified would be assessed.

3. The laboratory analytical soil data obtained for the contaminants in the CSA are used in statistical analysis to define the 95% upper confidence limit of the mean (UCL_{95}) for each contaminant. The UCL_{95} represents the concentration of a contaminant such that it can be said with 95% confidence that the mean value will not exceed this concentration. The UCL_{95} is compared against the maximum observed concentration, and the lesser of these two values is defined as the soil exposure concentration (C_{SE}) for the CSA.

4. Certain hydrogeologic parameters are required to estimate the impact of soil contaminants on groundwater quality. Parametric values representative of the Zone 2 hydrogeologic conditions (Table C.2) are used in the sample calculations presented in this appendix. The values for these parameters by contaminants are shown in Tables C.3 and C.4. Site-specific parameters might need to be collected during soil remediation. Hydrogeologic parameters include (a) planar area of soil contamination (Ap), (b) percolation rate (q_p), (c) saturated hydraulic conductivity (K_s), (d) horizontal hydraulic gradient (I), (e) source width, (f) depth of contamination (h), (g) depth to the water table from ground surface, (h) moisture content in the unsaturated zone, (i) effective porosity of the saturated zone, (j) distance traveled by the contaminant, (k) organic carbon fraction (f_{oc}), etc. Chemical parameters include the target groundwater concentration (C_w), soil-water distribution coefficient (K_d), and organic-carbon partition coefficient (K_{oc}). The target groundwater concentrations to be met are MCLs.

5. The soil remediation level for groundwater protection for each COC will be estimated using the analytical transport model developed by Summers et al. (1980). The concentration of any given COC, leached from the soil into the groundwater, is a function of the amount of the solute percolating through a theoretical soil column of negligible thickness, the amount of the chemical already present in the aquifer (if any), and the volume of water available for dissolution. The mathematical expression is as follows:

$$\mathrm{RL} = \mathrm{C_w} \times \{Kd + (\phi_w + \phi_a \times K_H)/\rho_b\} \times \left\{\frac{\mathrm{Q_P} + \mathrm{Q_A}}{\mathrm{Q_P}}\right\}$$

Table C.1. COCs for developing soil remediation levels for groundwater protection in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Chemicals of potential concern	Maximum observed groundwater concentrations at ETTP Zone 2[a] (mg/L or pCi/L)	MCL[b] (mg/L or pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential future groundwater COC?
		Volatile organic compounds			
1,1,1-Trichloroethane	1.40E+02	2.00E-01	104/795	17/795	**Yes**
1,1,2,2-Tetrachloroethane	1.10E-03	No	1/794		NA
1,1,2-Trichloroethane	4.10E-02	5.00E-03	25/794	5/794	**Yes**
1,1-Dichloroethane	6.30E+00	No	187/794		NA
1,1-Dichloroethene	2.80E+00	7.00E-03	152/794	87/794	**Yes**
1,2-Dichloroethane	4.20E-02	5.00E-03	15/794	10/794	**Yes**
1,2-Dichloroethene	6.71E+00	7.00E-02	384/695	175/695	**Yes**
2-Hexanone	3.30E-02	No	3/794		NA
Acetone	2.50E+00	No	82/786		NA
Benzene	1.70E-01	5.00E-03	64/797	26/797	**Yes**
Bromodichloromethane	6.00E-03	No	7/794		NA
Carbon tetrachloride	2.07E+00	5.00E-03	44/954	29/954	**Yes**
Chloroethane	5.70E-01	No	27/793		NA
Chloroform	9.04E+00	6.20E-03	181/954	95/954	**Yes**
Chloromethane	2.60E-01	No	16/794		NA
Methylene chloride	2.10E-01	5.00E-03	78/794	22/794	**Yes**
Tetrachloroethene	1.66E+01	5.00E-03	173/954	133/954	**Yes**
Toluene	6.40E+00	1.00E+00	55/797	2/797	**Yes**
Trichloroethene	1.90E+01	5.00E-03	579/952	489/952	**Yes**
Vinyl chloride	7.00E-01	2.00E-03	220/846	193/846	**Yes**
		Semivolatile organic compounds			
2,4-Dinitrotoluene	ND	No			NA
2-Methylnaphthalene	7.20E-02	No	7/165		NA
2-Nitrophenol	ND	No			NA
4-Bromophenyl phenyl ether	ND	No			NA
4-Chloro-3-methylphenol	ND	No			NA
4-Nitrophenol	ND	No			NA
Acenaphthylene	ND	No			NA
Benz(a)anthracene	ND	No			NA
Benzo(a)pyrene	ND	2.00E-04			No
Benzo(b)fluoranthene	ND	No			NA
Benzo(g,h,i)perylene	ND	No			NA
Bis(2-ethylhexyl)phthalate	9.10E-01	6.00E-03	164/165	164/165	**Yes**
Carbazole	9.00E-03	No	7/165		NA
Dibenz(a,h)anthracene	ND	No			NA
Indeno(1,2,3-cd)pyrene	ND	No			NA
N-Nitroso-di-n-propylamine	ND	No			NA
N-Nitrosodiphenylamine	1.80E-02	No			NA
Naphthalene	1.10E-01	No			NA
Phenanthrene	2.00E-03	No			NA
		PCBs and herbicides			
PCB-1248	ND	5.00E-04			No
PCB-1254	ND	5.00E-04			No
PCB-1260	ND	5.00E-04			No
		Metals			
Aluminum	5.83E+01	No	160/357		NA
Antimony	4.16E-02	6.00E-03	34/357	9/357	**Yes**
Arsenic	2.05E-01	1.00E-02	43/360	10/360	**Yes**
Barium	4.71E+00	2.00E+00	359/361	3/361	**Yes**

Table C.1. COCs for developing soil remediation levels for groundwater protection in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee (continued)

Chemicals of potential concern	Maximum observed groundwater concentrations at ETTP Zone 2[a] (mg/L or pCi/L)	MCL[b] (mg/L or pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential future groundwater COC?
Beryllium	6.50E-03	4.00E-03	36/357	2/357	**No[c]**
Cadmium	1.65E-02	5.00E-03	17/361	2/361	**No[c]**
Chromium IV*	4.47E+00	1.00E-01	145/352	16/352	**Yes**
Chromium III*	4.47E+00	1.00E-01	145/352	16/352	**Yes**
Copper	1.20E-01	1.30E+00	116/355	0/355	No
Lead	4.43E-02	1.50E-02	30/360	7/360	**Yes**
Lithium	1.00E-01	No	30/360		NA
Manganese	9.07E+01	No	296/361		NA
Mercury	1.00E-03	2.00E-03	7/299	0/299	No
Nickel	3.91E+00	No	112/357		NA
Selenium	8.80E-02	5.00E-02	45/360	6/360	**No[c]**
Thallium	1.13E-01	2.00E-03	31/357	31/357	**Yes**
Titanium	ND	No			NA
Uranium	9.80E-03	3.00E-02	8/12	0/12	No
Zirconium	ND	No			NA
		Radionuclides			
Cesium-134	ND	No			NA
Cesium-137	ND	No			NA
Cobalt-60	4.40E+00	No	1/36		NA
Europium-154	ND	No			NA
Neptunium-237	1.02E-01	No	7/18	0/18	Yes[f]
Plutonium-239	2.90E-02	No	1/19	0/19	Yes[f]
Radium-226	ND	No			NA
Radium-228	ND	No			NA
Strontium-90	1.40E+00	8[d]	1/39	0/39	No
Technetium-99	4.50E+03	900[d]	126/340	2/340	**No[c]**
Thorium-228	5.93E+00	No	5/31		NA
Thorium-230	3.01E+01	No	16/31		NA
Thorium-232	1.72E+00	No	5/30		NA
Uranium-234	8.22E+02	30[g]	191/277	16/277	**Yes**
Uranium-235	8.43E+01	30[g]	69/273	4/273	**Yes**
Uranium-236[e]	2.76E+01	30[g]	16/222	1/222	No
Uranium-238	3.42E+02	30[g]	134/263	6/263	**Yes**

[a]**Bold** constituents are the future groundwater COC.

[b]"No" in this column indicates an MCL value could not be found.

[c]Because there was only one MCL exceedance from an individual well, it is not considered as a COC.

[d]The value represents a derived MCL to meet the MCL of 4 mrem/yr.

[e]Because there was only one MCL exceedance out of 222 samples, it is not considered as a COC.

[f]This constituent is included as a potential future groundwater COC at the U. S. Environmental Protection Agency's request, although no MCL is available.

[g]Value is MCL in mg/L for total uranium; however, the derived activity of 20 pCi/L for each isotope will be used in the analyses.

*Concentrations are for total Chromium.

COC = contaminant of concern.

ETTP = East Tennessee Technology Park.

MCL = maximum contaminant level.

NA = not applicable as there is no MCL for the constituent.

ND = not detected.

PCB = polychlorinated biphenyl.

ROD = Record of Decision.

Table C.2. Hydrogeologic parameters for developing remediation levels for groundwater protection in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Parameter	Symbol	Units	Range of values (likeliest)	Comment[a]
Percolation rate (vertical)	q_p	feet/day	7.00E-6 to 1.37E-3 (3.15E-4)	Typical range for ETTP
Planar area of soil contamination	A_P	feet^2	522 to 248000 (21800)	Largest area based on K-1070-B
Saturated hydraulic conductivity (overburden)	K_S	feet/day	7.3E-06 to 21.7 (3.2)	Based on 98 measurements
Saturated hydraulic conductivity (bedrock)	K_S	feet/day	0.00084 to 220.2 (0.85)	Based on 76 measurements
Horizontal hydraulic gradient (overburden)	I	Unitless	0.005 to 0.12 (0.045)	Site-specific results
Horizontal hydraulic gradient (bedrock)	I	Unitless	0.003 to 0.095 (0.027)	Site-specific results
Aquifer thickness (overburden)	h	feet	4.7 to 43.8	Site-specific results
Aquifer thickness (bedrock)	h	feet	87.7 to 147.4	Site-specific results
Source width (perpendicular to flow)	w	feet	30 to 500	Largest width based on K-1070-B
Depth to water table from ground surface	d	feet	site-specific	
Moisture content in the unsaturated zone	Øw	unitless	site-specific	
Effective porosity	Ne	unitless	site-specific	
Distance traveled by contaminant	X_R	fet	site-specific	
Fraction organic carbon	f_{OC}	Unitless	1.58E-5 to 0.014 (0.0053)	Based on measurements in Bethel Valley and Rome Formation
Organic carbon distribution coefficient	K_{OC}	L/kg	constituent-specific[b]	
Soil-water distribution coefficient	K_d	L/kg	constituent-specific[c]	

[a]Selection of the parameters are discussed in Section C.3.
[b]Constituent-specific organic carbon distribution coefficients with the references are presented in Table C.4.
[c]Constituent-specific soil-water distribution coefficients with the references are presented in Table C.3.
ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

Table C.3. Target groundwater concentrations and K_d values for groundwater COCs in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Chemicals of concern	Target groundwater concentration[a] (mg/L or pCi/L)	K_d Likeliest[b] (mL/g)	K_d Range (mL/g)	Reference
		Metals		
Antimony	6.00E-03	1.50E+02	100 to 1,000	Shephard and Thibault 1990
Arsenic	1.00E-02		29 to 200	EPA 1996; Baes and Sharp 1984
Barium	2.00E+00	6.00E+01		Baes and Sharp 1984
Beryllium	4.00E-03	7.90E+02		EPA 1996
Cadmium	5.00E-03	1.89E+01	2.9 to 57.60	DOE 1995
Chromium-VI	1.00E-01	2.99E+01	2.2 to 1,000	Shephard and Thibault 1990
Chromium-III	1.00E-01	1.80E+06		EPA 1996
Lead	1.50E-02	5.50E+02	270 to 16,000	Shephard and Thibault 1990
Selenium	5.00E-02	1.50E+02		Shephard and Thibault 1990
Thallium (Thallium oxide)	2.00E-03	7.10E+01		EPA 1996
		Radionuclides		
Neptunium-237	0.707[c]	2.5E+01	1.3 to 79	Shephard and Thibault 1990
Plutonium-239	0.353[c]	1.20E+03	100 to 5,933	Shephard and Thibault 1990
Technetium-99	9.00E+02	5.00E-01	0.10 to 1.30	DOE 1996
Uranium-234	3.00E+01[d]	4.00E+01		DOE 1999a
Uranium-235	3.00E+01[d]	4.00E+01		
Uranium-238	3.00E+01[d]	4.00E+01		DOE 1999a

[a]Target groundwater concentrations are based on a maximum contaminant level (MCL).

[b]Likeliest values generally represent the average values from the range of values obtained from the literature or measured values.

[c]Target groundwater concentration for this constituent is based on the residential preliminary remediation goal at a risk level of 1E-06 as requested by the U. S. Environmental Protection Agency.

[d]Value is MCL in mg/L for uranium rather than an MCL for a specific isotope. However, the derived isotopic level of 20 pCi/L will be used to evaluate uranium isotopes.

COC = contaminant of concern.
ETTP = East Tennessee Technology Park.
DOE = U. S. Department of Energy.
K_d = soil-water distribution coefficient.
EPA = U. S. Environmental Protection Agency.
ROD = Record of Decision.

Table C.4. Target groundwater concentrations and organic carbon partition coefficients for organic COCs in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Chemicals of concern	Target groundwater concentration (mg/L)	K_{oc} (mL/g)	Henry's Law Constant (atm-m^3/mol)
1,1,1-Trichloroethane	2.00E-01	1.35E+02	1.72E-02
1,1,2-Trichloroethane	5.00E-03	7.50E+01	9.13E-04
1,1-Dichloroethene	7.00E-03	6.50E+01	2.61E-02
1,2-Dichloroethane	5.00E-03	3.80E+01	9.79E-04
1,2-Dichloroethene	7.00E-02	7.75E+01	6.60E-03
Benzene	5.00E-03	6.17E+01	5.55E-03
Carbon tetrachloride	5.00E-03	1.52E+02	3.04E-02
Chloroform	6.20E-03	5.25E+01	3.67E-03
Methylene chloride	5.00E-03	1.00E+01	2.19E-03
Tetrachloroethene	5.00E-03	2.65E+02	1.84E-02
Toluene	1.00E+00	1.40E+02	6.64E-03
Trichloroethene	5.00E-03	9.40E+01	1.03E-02
Vinyl chloride	2.00E-03	1.86E+01	2.70E-02
Bis(2-ethylhexyl)phthalate	6.00E-03	1.11E+05	1.02E-07

K_{oc} values from U. S. Environmental Protection Agency *Soil Screening Guidance: Technical Background Document*, May 1996.
Target groundwater concentrations are based on a maximum contaminant level for drinking water.
COC = contaminant of concern. ETTP = East Tennessee Technology Park. ROD = Record of Decision.

where

RL = remediation level for groundwater protection (mg/kg or pCi/g),
C_w = target groundwater concentration (MCL) (mg/L or pCi/L),
K_d = soil-water distribution coefficient (L/kg),
ϕ_w = average soil moisture content (%),
ϕ_a = air-filled soil porosity (%),
ρ_b = soil dry bulk density, (g/cm^3),
Q_p = volumetric rate of percolation (m^3/day)
Q_p = $q_p \times A_P$,
q_p = percolation rate (m/day),
A_P = planar area of soil contamination (m^2),
Q_A = volumetric flow of groundwater (m^3/day)
Q_A = $K_S \times I \times A_A$,
K_S = saturated hydraulic conductivity (m/day),
I = horizontal hydraulic gradient (m/m),
A_A = cross-sectional area perpendicular to flow (m^2).

The Summer's model incorporates the physical and chemical characteristics of the solute and the characteristics of the receiving aquifer to simulate the migration of the solute. The model is considered to be highly conservative. In addition, the calculated concentration is considered to be highly dependent on K_d values, which can range over several orders of magnitude. As such, the uncertainty in the result can range over several orders of magnitude, especially for metals and radionuclides. Therefore, to evaluate the uncertainty in the result, statistical distributions for the remediation levels are predicted in three steps. First, the model is set up in a Microsoft Excel® spreadsheet,[1] linked to Crystal Ball, a forecasting software based on Monte Carlo simulation technique. Monte Carlo simulation has applicability to East Tennessee Technology Park (ETTP) Zone 2 because of the variability and uncertainty of representativeness of average sample values of model input variables other than the K_d such as the hydraulic conductivity and hydraulic gradient. Combining observations from both areas underlain by the Rome Formation and by the Chickamauga Supergroup formations adds to the variability in the data sets for several variables. Second, distributions for the input parameters (e.g., lognormal distribution for hydraulic conductivity, uniform distribution for hydraulic gradient, triangular distribution for the K_d values, and so on) are assumed. Third, Crystal Ball simulations are conducted to predict statistical distributions for the remediation levels for protection of groundwater.

C.2.2 CALCULATIONS OF LIMITING CONTAMINANT CONCENTRATIONS IN SOIL

1. The fraction factor f_i (= $C_{SE,i}/RL_i$) for each contaminant represents the impact it might have on groundwater contamination.

2. If the f_i value for a contaminant is less than 1, then that particular contaminant is dropped from further calculation, and calculation progresses with the rest of the contaminants.

3. The fraction factors, f_i, for the site-specific contaminants determine whether the soil requires remediation to minimize impacts to groundwater. If f_i < 1.0 for all the COCs, then no further

[1]Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

calculation is necessary. It can be concluded that soil remediation is not required. If $f_i > 1.0$ for one or more of the COCs, soil remediation is necessary.

4. Modeling is performed using SESOIL. The model calculates contaminant flux into the shallow water table beneath the site over a 100-year period for organics and a 1000-year period for metals and radionuclides. Using the results from the leachate modeling, saturated flow and contaminant transport modeling is performed using AT123D. This model predicts the maximum groundwater concentration (C_{gw}) at the receptor location.

5. Based on the maximum groundwater contamination after migration and natural attenuation, the remediation level is revised using the following equation:

$$RL_R = C_W \times \frac{C_{SE}}{C_{GW}}$$

where

RL_R = revised remediation level (mg/kg or pCi/g),
C_W = target groundwater concentration based on MCL (mg/L or pCi/L),
C_{SE} = soil exposure concentration for the area of soil contamination (pCi/g or mg/kg),
C_{gw} = AT123D-predicted maximum groundwater concentration at the receptor location (pCi/L or mg/L).

6. The revised remediation levels are considered the limiting contaminant concentrations. These values are again compared with the respective C_{SE} values of the contaminant, and the fraction factor f_i, is calculated.

$$f_i = \frac{C_{SE\,i}}{RL_{Ri}}$$

7. The fraction factors, f_i, for the site-specific contaminants determine whether the soil requires remediation to minimize impacts to groundwater.

8. If $f_i < 1.0$ for all the COCs, then soil remediation is not required.

9. If $f_i > 1.0$ for one or more of the COCs, soil remediation is necessary, and the volume of soil that should be remediated (i.e., soil within the RL_R) is calculated by developing a three-dimensional concentration isosurface.

C.3. DESCRIPTION OF THE DEVELOPMENTS OF SCREENING REMEDIATION LEVELS

This section first discusses the parameters used in developing screening remediation levels and then discusses the process used to develop those levels. The screening remediation levels are used initially in comparing soil concentrations to determine if the potential for a groundwater source exists. If the soil concentrations exceed the screening remediation levels, then the more detailed approach described in Section C.2 is used to calculate site-specific remediation levels.

C.3.1 VERTICAL PERCOLATION

Precipitation in ETTP Zone 2 is seasonally distributed. Evapotranspiration (ET) is at a maximum from July to September during the vegetative growing season. Runoff is greatest in the winter when ET is low and precipitation is high. Precipitation not lost as ET or as quick surface runoff percolates through the soil and eventually recharges the deep groundwater system. The most likely vertical percolation or recharge to the shallow groundwater system in Zone 2 is 1.25 in./year (3.2 cm/year), based on Gerald Moore's water budget analysis for the groundwater parameters and flow systems near ORNL (Moore 1992). The ranges of values used for these parameters are shown in Table C.2. These ranges were based on findings from previous investigations and published literature (Moore 1992, DOE 1999b).

C.3.2 HORIZONTAL AREA OF SPILL

Contaminated soil areas will be determined based on known leakage or spill locations or other subsurface contaminated soil mass that has groundwater COCs present. A CSM will be developed to define the basis of input parameters required for the contaminant transport modeling for the individual areas. The range of values used in this analysis is based on a small area to a maximum area equivalent to K-1070-B for the contaminated soils in the Chickamauga Formation and to a maximum area equivalent to the K-1401 Acid Line for the Rome Formation. Because of limited information on the nature and extent of contamination, a uniform distribution is chosen for this parameter.

C.3.3 HYDRAULIC CONDUCTIVITY AND GRADIENT IN SATURATED ZONE

Hydraulic conductivity data presented in Energy Systems (1995) and U. S. Department of Energy (DOE) [1995 and 1998] have been used to determine representative values for the saturated overburden and the Chickamauga Supergroup and Rome Formation bedrock at ETTP. The hydraulic conductivity data, determined by slug tests in wells, indicate that the K_s values for the overburden materials overlying the Rome Formation range from 7.3E-06 to 5.5E-01 feet/day with an average value of 6.7E-02 feet/day. These values are based on slug test results from 39 wells completed in the overburden above the subcrop area of the Rome Formation. The K_s values for saturated Rome Formation bedrock range from 3.0E-03 to 1.67 feet/day with an average value of 9.5E-02 feet/day. These values are based on the results from nine wells completed in Rome Formation bedrock. The K_s values for the overburden materials overlying the Chickamauga Supergroup range from 1.5E-03 to 2.2E+01 feet/day with an average value of 5.3E+00 feet/day. These values are based on slug test results from 59 wells completed in the overburden above the subcrop area of the Chickamauga. The K_s values for saturated Chickamauga Supergroup bedrock range from 8.4E-04 to 2.2E+02 feet/day with an average value of 1.3E+01 feet/day. These values are based on the results from 67 wells completed in Chickamauga bedrock at ETTP. However, for this analysis, the observed hydraulic conductivity values from both Chickamauga and Rome Formations were combined to develop the range and the likeliest value for a triangular distribution used for Monte Carlo simulations.

Groundwater flow in Zone 2 is generally toward the bounding surface water bodies (i.e., toward Mitchell Branch in the northwest portion; toward Poplar Creek, K-901-A Pond, and Clinch River in the western portions; and toward the K-1007-P Ponds in the southern portion). Horizontal hydraulic gradients were determined from a sitewide potentiometric map of ETTP prepared from water level data from June 2000 and supplemented by water level data from December 2002. The hydraulic gradients determined for the overburden materials overlying the subcrop area of the Rome Formation generally range from 1.0E-02 to 1.2E-01 with an average value of 1.0E-01. Horizontal gradients for the Rome Formation bedrock generally range from 3.0E-02 to 9.5E-02 with a general average gradient of 5.0E-02. Horizontal hydraulic gradients for the overburden materials overlying the subcrop area of the Chickamauga Supergroup generally range from 5.0E-03 to 2.0E-01 with a general average value of 2E-02. Horizontal gradients in bedrock of the

Chickamauga Supergroup generally range from 3.0E-03 to 4.0E-02 with an average value of 1.5E-02. It should be noted that horizontal gradients may vary widely at ETTP depending on location and time of year. According to the Summer's model, a lower conductivity leads to a smaller volume of groundwater flow in the mixing zone. As less groundwater volume becomes available for diluting a given influx of contaminant into the mixing zone, the lower conductivity leads to a lower remediation level. Like the hydraulic conductivity values, the hydraulic gradients were also combined for the formations for the Monte Carlo simulation.

C.3.4 AQUIFER THICKNESS

The ETTP Zone 2 area is underlain by the Rome Formation, located to the east, in contact with the younger Middle Ordovician-age rocks of the Chickamauga Supergroup, located to the west (Hatcher et al. 1992, MMES 1994). The rocks of the Rome Formation strike generally east–west while the rocks of the Chickamauga Supergroup generally strike northeast–southwest. The Rome Formation consists of thin-bedded shales, siltstones, and sandstones with some minor limestone beds in the lower part of the formation. The Chickamauga Supergroup generally consists of interbedded limestones, argillaceous limestones, occasional calcareous shale beds, and some chert-rich zones. For the purposes of this methodology, aquifer thickness for the overburden materials is based on the saturated thickness observed in wells completed in the overburden materials. The saturated thickness was determined using the December 2002 water level measurements and the depth to the top of bedrock (generally assumed to be auger refusal) at a given well. The aquifer thickness determined for bedrock represents a saturated thickness calculated using observed depth to water measurements from the December 2002 water levels and a total well depth of 150 feet. The results based on these analyses indicate that the aquifer thickness for the overburden in the subcrop area of the Rome Formation ranges from 4.7 to 22.1 feet with an average thickness of 12.3 feet. These values are based on the saturated thickness observed in 38 wells completed in overburden in the subcrop area of the Rome Formation. The aquifer thickness for the Rome Formation bedrock ranges from 87.7 to 145.3 feet with an average thickness of 126.4 feet. These values are based on the results from 12 wells completed in bedrock of the Rome Formation. The aquifer thickness for the overburden in the subcrop area of the Chickamauga Supergroup ranges from 1.5 to 43.8 feet with an average thickness of 15.5 feet. These values are based on the saturated thickness observed in 66 wells completed in overburden in the subcrop area of the Chickamauga. The aquifer thickness for the Chickamauga bedrock ranges from 99.6 to 147.4 feet with an average thickness of 129.4 feet. These values are based on the results from 53 wells completed in bedrock of the Chickamauga Supergroup. A uniform distribution is used for the aquifer thickness.

C.3.5 SOURCE LENGTH PARALLEL TO GROUNDWATER FLOW

The source length parallel to groundwater flow is related to the horizontal area of spill. According to the Summer's model, a longer length leads to larger influx of contaminants in the mixing zone, consequently leading to a lower trigger level for a given target groundwater concentration. A uniform range based on horizontal area of soil contamination is used in this analysis.

C.3.6 MIXING ZONE THICKNESS

The evaluation is based on the assumption that a groundwater well with a screen of aquifer thickness will be extracting water from Zone 2. Therefore, it is quite appropriate to assume that water in the well will be mixed for this thickness. However, if the well is screened in the uppermost portion of the aquifer, then this assumption will not be valid, and a mixing zone depth calculated based on EPA's equation [presented on pp. 44–45 of EPA's *Soil Screening Guidance: Technical Background Document* (EPA Office of Emergency and Remedial Response Publication 9355.4-17A, May 1996)] may be used for the evaluation of soil remediation levels. Therefore, to be conservative, EPA's equation on mixing zone depth, as shown below, will be used for developing the dilution attenuation factors used in the Summer's model:

$$d = \sqrt{0.0112 \times L^2} + H \times \left[1 - \exp\left(\frac{-L \times q_P}{Ks \times I \times H}\right)\right]$$

where

d	=	mixing zone depth (m),
Ks	=	aquifer hydraulic conductivity (m/yr),
g	=	horizontal hydraulic gradient (m/m),
I	=	percolation rate (m/yr),
L	=	source length parallel to groundwater flow (m),
H	=	aquifer thickness (m),
d	≤	H.

C.3.7 FRACTION ORGANIC CARBON

The fraction of organic carbon (f_{oc}) is selected based on 12 measured values of total organic carbon (TOC) content in Zone 2. Sampling done for the RI report for the K-1070-C/D area (overlying the Rome Formation) revealed a wide range of TOC values. TOC decreased from the shallow sample interval to the deeper sample interval in each sample location across the site and ranged from 0.02% to a maximum of 1.14% with an average of 0.3%. Measurements were not available for the Chickamauga Formation. However, a range and average were developed for Zone 2 f_{oc}-based combined measurements from the Rome Formation and Bethel Valley (which is representative of the Chickamauga Formation). According to the Summer's model, a lower f_{oc} yields a lower K_d, and the lower K_d leads to a lower remediation level. A lower K_d reduces the soils' capacity to contain contaminants through adsorption. In areas of significant volatile organic compound (VOC) contamination of soils, additional f_{oc} measurements could be made to refine the analysis of potential VOCs in soil to contaminate underlying groundwater.

C.3.8 SOIL-WATER DISTRIBUTION COEFFICIENT

The K_ds for metals and inorganic compounds and for radionuclides were obtained based on previous investigations and published literature values. The value of the coefficient for a chemical may vary over a wide range, and selection of a unique value for the coefficient becomes difficult. Therefore, if available, statistical distributions of K_d values using a Latin Hyper-cube sampling technique were utilized for selection of a chemical-specific K_d value. If site-specific values are not found, the value is taken from *Soil Screening Guidance: Technical Background Document* (EPA 1996). If the value is not found in EPA (1996), the value is searched in Sheppard and Thibault (1990) for loam. Finally, if the value is not found in Sheppard and Thibault (1990), the value is searched in Baes and Sharp (1984). A unique value for each element in the periodic table is presented in Baes and Sharp (1984). A distribution was assigned to the K_d of each metal based on data provided in Sheppard and Thibault (1990). However, if a distribution of K_d was not available, then a uniform or triangular distribution was used based on the availability of K_d data.

The soil-water distribution coefficients for VOCs are estimated as the product of f_{oc} and K_{oc}. The selection of f_{oc} is discussed above. Values for K_{oc} may be found in EPA (1996) or in the EPA Treatability Database (EPA 1994).

C.3.9 CALCULATION OF ZONE 2 SOIL SCREENING LEVELS FOR GROUNDWATER PROTECTION

Summer's model linked to Crystal Ball was applied to each COC for predicting its remediation level. The results of the model application to all the COCs are shown in Table C.5. The first column lists the COCs. The second column lists the maximum observed groundwater concentrations, and the third column lists the MCL values if available. If the observed maximum groundwater concentration of a COC is greater than its MCL, then the observed value is highlighted. As can be seen from Table C.5, observed concentrations of several VOCs and metals are highlighted as well as the uranium isotopes. Columns 4 and 5 present the frequency of detects and frequency of MCL exceedances. The sixth and seventh columns list exposure concentrations and the 90th percentile remediation levels, respectively, and comparisons between the exposure concentrations and remediation levels are shown in the last column. As can be seen from Table C.5, none of the VOCs from the list of soil contaminants of potential concern with respect to their leaching from soils to groundwater is predicted to be a potential future groundwater COC despite the presence of VOCs in significant concentrations in groundwater. This is mainly because the VOCs from this site have either already leached out of the unsaturated zone or biodegraded. As shown in Table C.5, currently observed soil exposure concentrations of only ^{234}U and ^{238}U exceeded their respective remediation levels. Therefore, based on currently observed soil data, it may be concluded that soil cleanup will be required for only those CSAs overlying either Rome or Chickamauga Formations that have higher concentrations of ^{234}U and ^{238}U.

C.4. EXAMPLE CALCULATION OF ETTP ZONE 2 SOIL REMEDIATION LEVELS FOR SELECTED SITES WITHIN ZONE 2 FOR GROUNDWATER PROTECTION

The areas selected to demonstrate the use of the process outlined in Section C.2 include the K-1420 (Oil Storage Facility) area, K-1070-C/D area, and K-1401 acid lines.

C.4.1 K-1420 AREA

The K-1420 area soil has been contaminated with oil containing polychlorinated biphenyls and 2 to 3% uranium. Between 1954 and the late 1960s, the K-1421 Incinerator was used to burn waste oil sludge and low-level contaminated combustibles. A groundwater plume with elevated VOCs emerges from the K-1420 building and passes beneath the K-1420 area.

The Zone 2 COCs presented in Table C.1 were initially evaluated as COCs for the K-1420 area. Then chemicals that were not detected in K-1420 area soils and groundwater were excluded as COCs.

A CSM was developed to define the basis of input parameters required for the contaminant transport modeling. The bedrock geology of the K-1420 area has been mapped as consisting of rocks of Rome Formation (Hatcher et al. 1992) with interbedded layers of limestone and shale. The general direction of groundwater flow is west toward Poplar Creek, 572 m (1875 feet) from the K-1420 area. The hydrogeologic properties used in the remediation level calculation are presented in Table C.6 with references. The analytical soil data obtained for the COCs were used in a statistical analysis to develop the C_{SE} for the K-1420 area in order to compare against the predicted remediation levels for groundwater protection.

Table C.5. Summary of predicted soil remediation levels for protecting groundwater based on MCLs for all the sites overlying both the Chickamauga and Rome Formations in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Chemicals of concern	Maximum groundwater concentrations[a] (mg/L or pCi/L)	MCL[b] (mg/L or pCi/L)	Frequency of detect	Frequency of MCL exceedances	Soil exposure concentration (C_{SE}) (mg/kg or pCi/g)	Remediation level based on 90th percentile (mg/kg or pCi/g)	C_{SE} > RL?
			Volatile organic compounds				
1,1,1-Trichloroethane	1.40E+02	2.00E-01	104/795	17/795	1.33E-02	9.79E+01	No
1,1,2-Trichloroethane	4.10E-02	5.00E-03	25/794	5/794	1.58E-02	1.37E+00	No
1,1-Dichloroethene	2.80E+00	7.00E-03	152/794	87/794	ND	1.75E+00	No
1,2-Dichloroethane	4.20E-02	5.00E-03	15/794	10/794	1.57E-02	7.29E-01	No
1,2-Dichloroethene	6.71E+00	7.00E-02	384/695	175/695	1.82E-01	2.00E+01	No
Benzene	1.70E-01	5.00E-03	64/797	26/797	1.31E-02	1.15E+00	No
Bis(2-ethylhexyl)phthalate	9.10E-01	6.00E-03	164/165	164/165	7.23E-01	2.35E+03	No
Carbon tetrachloride	2.07E+00	5.00E-03	44/954	29/954	2.00E-03	2.77E+00	No
Chloroform	9.04E+00	6.20E-03	181/954	95/954	1.15E-02	1.23E+00	No
Methylene chloride	2.10E-01	5.00E-03	78/794	22/794	3.20E-02	2.41E-01	No
Tetrachloroethene	1.66E+01	5.00E-03	173/954	133/954	1.42E+00	4.72E+00	No
Toluene	6.40E+00	1.00E+00	55/797	2/797	3.47E-02	5.02E+02	No
Trichloroethene	1.90E+01	5.00E-03	579/952	489/952	1.08E-01	1.72E+00	No
Vinyl chloride	7.00E-01	2.00E-03	220/846	193/846	ND	1.76E-01	No
			Metals				
Antimony	4.16E-02	6.00E-03	34/357	9/357	1.74E+00	1.44E+02	No
Arsenic	2.05E-01	1.00E-02	43/360	10/360	8.45E+00	6.63E+01	No
Barium	4.71E+00	2.00E+00	359/361	3/361	1.25E+02	9.15E+03	No
Chromium	4.47E+00	1.00E-01	145/352	16/352	3.69E+01	1.72E+02	No
Lead	4.43E-02	1.50E-02	30/360	7/360	1.65E+02	3.37E+03	No
Thallium	1.13E-01	2.00E-03	31/357	31/357	8.67E-01	1.08E+01	No
			Radionuclides				
Neptunium-237	1.02E-01	7.07E-01[d]	7/18	0/18	3.30E+00	NR[e]	NA
Plutonium-239	2.9E-02	3.53E-01[d]	1/19	0/19	2.30E+00	NR[e]	NA
Uranium-234	**8.22E+02**	**20[c]**	**191/277**	**16/277**	**3.49E+02**	**6.11E+01**	**Yes**
Uranium-235	8.43E+01	20[c]	69/273	4/273	3.09E+01	6.11E+01	No
Uranium-238	**3.42E+02**	**20[c]**	**134/263**	**6/263**	**9.17E+01**	**6.11E+01**	**Yes**

Table C.5. Summary of predicted soil remediation levels for protecting groundwater based on MCLs for all the sites overlying both the Chickamauga and Rome Formations in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee (continued)

[a]Highlighting/shading indicates that the observed maximum groundwater concentration exceeds the maximum contaminant level (MCL).
[b]"No" in this column indicates that an MCL could not be found; therefore, the remediation level was not calculated for the constituent.
[c]Although an MCL for the individual uranium isotopes is not currently available, there is an MCL for total uranium, and the value in the table represents a derived MCL.
The residential preliminary remediation goal (PRG) at a risk level of 1E-06 was used as requested by the U. S. Environmental Protection Agency.
[e]A remediation level for the constituent is not required because the maximum observed groundwater concentration is below its risk-based PRG.
*Concentrations are for total chromium.
Bold indicates that the soil exposure concentration exceeds the remediation level.

C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level.
ND = not detected.
PCB = polychlorinated biphenyl.
RL = remediation level.
ROD = Record of Decision.

Table C.6. Hydrogeologic parameters for developing remediation levels for groundwater protection in the K-1420 Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Parameter	Symbol	Units	Range of values (likeliest)	Comment
Percolation rate (vertical)	q_p	feet/day	7.00E-6 to 1.37E-3	Typical range for ETTP
Planar area of soil contamination	A_P	feet^2	41,000	Estimated from map of the two subareas within the K-1420 area
Saturated hydraulic conductivity (overburden)	K_S	feet/day	0.104 to 0.437 (0.292)	Based on field measurements for UNW-063, UN-094, and UNW-095
Saturated hydraulic conductivity (bedrock)	K_S	feet/day	0.159 to 1.67 (0.85)	Based on field measurements for BRW-039 and BRW-047
Horizontal hydraulic gradient (overburden)	I	unitless	0.03 to 0.033	Estimated from potentiometric map in the vicinity of the K-1420 area
Horizontal hydraulic gradient (bedrock)	I	unitless	0.003 to 0.095 (0.027)	Typical range for Rome Formation in ETTP
Aquifer thickness (overburden)	h	feet	18 to 23	K-1420 Site Summary Document
Aquifer thickness (bedrock)	h	feet	87.7 to 126.4	Typical range for Rome Formation in ETTP
Source width (perpendicular to flow)	w	feet	460	Estimated from map for the K-1420 contaminated soil area
Fraction organic carbon	f_{OC}	unitless	2.0E-4 to 1.14E-2 (0.00355)	Based on 12 measurements
Organic carbon distribution coefficient	K_{OC}	L/kg	constituent-specific	See Table C.4
Soil-water distribution coefficient	K_d	L/kg	constituent-specific	See Table C.3

ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

The Summer's model linked to Crystal Ball was applied to each COC for predicting its remediation level. The results of the model application to all the COCs are shown in Table C.7. The first column lists the COCs. The second column lists the maximum observed groundwater concentrations, and the third column lists the MCL values if available. If the observed maximum groundwater concentration of a COC is greater than its MCL, then the observed value is shaded. As can be seen from Table C.7, observed concentrations of several VOCs and metals are shaded, and ^{99}Tc and the uranium isotopes are shaded. Columns 4 and 5 present the frequency of detects and frequency of MCL exceedances. The sixth column identifies whether the ETTP Zone 2 COC is a K-1420 Area COC. If a Zone 2 COC is detected in groundwater only once exceeding its MCL, then that constituent is not considered as a K-1420 COC. Therefore, a remediation level was not developed for the constituent. The seventh and eighth columns list exposure concentrations and the 90th percentile remediation levels, respectively, and comparisons between the exposure concentrations and remediation levels are shown in the 9th column. As can be seen from Table C.7, currently observed soil exposure concentrations of only ^{234}U exceeded its remediation level. Therefore, a refined assessment was performed for ^{234}U, using SESOIL and AT123D, and a revised remediation level for ^{234}U was developed. As shown in the last column of Table C.7, the revised remediation level for ^{234}U (374 pCi/g) is less than the currently observed soil exposure concentration (655 pCi/g); therefore, it may be concluded that soil cleanup for groundwater protection will be required for the K-1420 area.

Table C.7. Summary of predicted soil remediation levels for groundwater protection based on MCLs for the K-1420 Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

ETTP Zone 2 COC	Maximum observed groundwater in K-1420[a] (mg/L, pCi/L)	MCL (mg/L, pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential groundwater COC?	Soil exposure concentration (C_{SE}) (mg/kg, pCi/g)	RLs based on 90th percentile (mg/kg, pCi/g)	C_{SE} > RL ?	COCs selected for SESOIL and AT123D modeling	Revised RL (pCi/g)
Volatile organic compounds										
1,1,1-Trichloroethane	ND	2.00E-01			No	0.00291	NA	NA		
1,1,2-Trichloroethane	ND	5.00E-03			No	0.00264	NA	NA		
1,1-Dichloroethene[b]	9.00E-03	7.00E-03	3/40	1/40	No	ND	NA	No		
1,2-Dichloroethane	ND	5.00E-03			No	0.00397	NA	NA		
1,2-Dichloroethene	6.80E-01	7.00E-02	15/25	6/25	**Yes**	0.0103	9.86E-01	No		
Benzene	ND	5.00E-03			No	ND	NA	NA		
Carbontetrachloride	ND	5.00E-03			No	ND	NA	NA		
Chloroform	ND	6.20E-03			No	0.00338	NA	NA		
Methylene chloride[b]	1.30E-02	5.00E-03	3/40	1/40	No	0.0117	NA	No		
Tetrachloroethene	1.20E-02	5.00E-03	9/40	3/20	**Yes**	0.00753	1.84E-01	No		
Toluene	3.00E-03	1.00E+00	1/40	0/40	No	0.00293	NA	NA		
Trichloroethene	5.80E-01	5.00E-03	25/40	22/40	**Yes**	0.0179	8.10E-02	No		
Vinyl Chloride	1.10E-02	2.00E-03	9/40	5/40	**Yes**	ND	1.96E-02	No		
Semivolatile organic compound										
Bis(2-ethylhexyl)phthalate	6.80E-01	6.00E-03	8/8	8/8	**Yes**	0.301	7.34E+01	No		
Metals										
Antimony	2.70E-03	6.00E-03	1/20	0/20	No	5.6	NA	No		
Arsenic	2.05E-01	1.00E-02	3/20	2/20	**Yes**	9.26	2.48E+01	No		
Barium[b]	4.46E+00	2.00E+00	20/20	1/20	No	87.3	NA	No		
Chromium IV*[b]	1.60E+00	1.00E-01	8/20	1/20	No	27.6	NA	No		
Chromium III*[b]	1.60E+00	1.00E-01	8/20	1/20	No	27.7	NA	No		
Lead	ND	1.50E-02			No	554	NA	No		
Thallium	1.13E-01	2.00E-03	2/20	2/20	**Yes**	0.725	3.85E+00	No		
Radionuclides										
Neptunium-237	1.02E-01	7.07E-01[e]	3/4	0/4	No	8.56	NA	NA		
Plutonium-239	2.9E-02	3.53E-01[e]	2/7	0/7	No	3.72	NA	NA		
Uranium-234[c]	**7.42E+02**	**2.00E+01[d]**	**12/14**	**5/14**	**Yes**	**655**	**2.17E+01**	**Yes**	**Yes**	**3.74E+02**
Uranium-235[b]	3.14E+01	2.00E+01[d]	11/15	1/15	No	55.3	NA	NA		
Uranium-238[b]	1.40E+02	2.00E+01[d]	9/11	1/11	No	103	NA	NA		

Table C.7. Summary of predicted soil remediation levels for groundwater protection based on MCLs for the K-1420 Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee (continued)

[a]Highlighting indicates that the observed maximum groundwater concentrations exceed the MCL, and, therefore, these constituents represent K-1420 Area potential COCs.
[b]The constituent was not considered as a COC for developing remediation level because it was detected only once exceeding its MCL.
[c]A **bold** constituent represents the COCs that requires soil cleanup at this site.
[d]Although an MCL for the individual uranium isotopes is not currently available, there is an MCL for total uranium, and the value in the table represents a derived MCL.
[e]The residential preliminary remediation goal at a risk level of 1E-06 was used as requested by the U. S. Environmental Protection Agency.
*Concentrations are for total chromium.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional Model.
COC = contaminant of concern.
C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level.
NA = not applicable.
ND = not detected.
RL = remediation level.
ROD = Record of Decision.
SESOIL = Seasonal Soil Compartment Model.

C.4.2 K-1070-C/D AREA

The K-1070-C/D Burial Ground is an 8.9-hectare (ha) tract of land within the security fence on the eastern side of the ETTP main plant area. K-1070-C/D is a former disposal area for waste, including hazardous and radiological constituents, associated with activities at the ETTP site. Of the several disposal sites at K-1070-C/D area, three have been selected for the evaluation process described in Section C.2: (1) South Pits area, (2) K-1070-C area, and (3) the Concrete Pad area.

C.4.2.1 The South Pits area

The South Pits area within the scope of this evaluation includes the southern portion of the pits area in K-1070-C/D, surrounding the G-Pit. The G-Pit was used from 1977 to 1979 as a disposal unit for solvents and other organic based liquids generated from activities at ETTP. A remedial investigation (RI) (DOE 1995) identified the G-Pit as the primary source of contamination to a volatile organic compound (VOC) plume migrating away from the burial ground area. Under a previous remedial action waste materials in the G-Pit area were excavated down to 15 feet and filled with flowable concrete mix, thus removing a major source of groundwater contamination in the pits area.

The COC selection process for this site is identical to the one for K-1420 area discussed in Section C.4.1. The Zone 2 COCs presented in Table C.1 were initially evaluated as COCs for the South Pits area. Chemicals not detected in South Pits area soils and groundwater were then excluded as COCs. The contaminant concentrations in the groundwater of the immediate vicinity (i.e., wells UNW-114, BRW-096 and UNP-002) were screened against their respective MCL values. If any chemical concentration exceeded their respective target concentration even once, the chemical was retained as a COPC.

A CSM was developed to define the basis of input parameters required for the contaminant transport modeling. The bedrock geology of the South Pits area has been mapped as consisting of rocks of Rome Formation (Hatcher et al. 1992) with interbedded layers of limestone and shale. The general direction of groundwater flow is westward. The range of values for hydrogeologic properties used in the remediation level calculation is presented in Table C.8 with references. The analytical soil data obtained for the COCs were used in a statistical analysis to develop the C_{SE} for the South Pits area. The values were compared against the predicted remediation levels to determine if contaminant transport model (SESOIL and AT123D) simulations were needed for any contaminant.

The Summer's model linked to Crystal Ball was applied to each COC and the 90th percentile was taken as its remediation level. The results of the model application to all the COCs are shown in Table C.9. The first column lists the COCs. The second column lists the maximum observed groundwater concentrations, and the third column lists the MCL values, if available. Columns 4 and 5 present the frequency of detects and frequency of MCL exceedances. The seventh and eighth columns list exposure concentrations and the 90th percentile remediation levels, respectively, and comparisons between the exposure concentrations and remediation levels are shown in the 9th column. The contaminants selected for SESOIL and AT123D modeling were 1,1-dichloroethene, tetrachloroethene and trichloroethene. The AT123D predicted maximum groundwater concentration was used to calculate the revised RL and is listed in the last column of Table C.9. Since the revised RL values for each of the three contaminants are greater than their respective C_{SE} values, it may be concluded that soil cleanup for groundwater protection will not be required for the South Pits area.

Table C.8. Hydrogeologic parameters for developing remediation levels for groundwater protection in the South Pits Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Parameter	Symbol	Units	Range of values (likeliest)	Comment
Percolation rate (vertical)	q_P	feet/day	7.00E-6 to 1.37E-3	Typical range for ETTP
Planar area of soil contamination	A_P	feet^2	10,000 to 55,000	Estimated from the map of South Pits area
Saturated hydraulic conductivity (overburden)	K_S	feet/day	7.3E-06 to 5.53 (0.67)	Based on field measurements for Rome Formations within ETTP
Saturated hydraulic conductivity (bedrock)	K_S	feet/day	3E-03 to 1.67	Based on field measurements for Rome Formations within ETTP
Horizontal hydraulic gradient (overburden)	I	unitless	0.096 to 0.114	Estimated from potentiometric map in the vicinity of the South Pits area
Horizontal hydraulic gradient (bedrock)	I	unitless	0.03 to 0.095	Typical range for Rome Formation in ETTP
Aquifer thickness (overburden)	h	feet	4.7 to 43.8	K-1070-C/D Site Summary Document
Aquifer thickness (bedrock)	h	feet	87.7 to 147	Typical range for Rome Formation in ETTP
Source width (perpendicular to flow)	w	feet	100 to 250	Estimated from map for the South pits contaminated area within K-1070-C/D area
Fraction organic carbon	f_{OC}	unitless	9.4E-4 to 7.0E-3 (0.0029)	Site-specific measurements.
Organic carbon distribution coefficient	K_{OC}	L/kg	constituent-specific	See Table C.4
Soil-water distribution coefficient	K_d	L/kg	constituent-specific	See Table C.3

ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

Table C.9. Summary of predicted soil remediation levels for groundwater protection based on MCLs for the South Pits Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

ETTP Zone 2 COC	Maximum observed groundwater in K-1070-C/D South Pits[a] (mg/L, pCi/L)	MCL (mg/L, pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential groundwater COC?	Soil exposure concentration (C_{SE}) (mg/kg, pCi/g)	RLs based on 90th percentile (mg/kg, pCi/g)	C_{SE} > RL?	COCs selected for SESOIL and AT123D modeling	Revised RL (mg/kg, pCi/g)
				Volatile organic compounds						
1,1,1-Trichloroethane	1.40E+02	2.00E-01	12/19	12/19	Yes	3.82E-02	5.00E-01	No		
1,1,2-Trichloroethane	4.10E-02	5.00E-03	4/19	2/19	Yes	ND	8.87E-03	No		
1,1-Dichloroethene	2.80E+00	7.00E-03	13/19	13/19	Yes	3.90E-02	1.30E-02	Yes	Yes	9.48E-01
1,2-Dichloroethane	2.00E-03	5.00E-03	1/19	0/19	No	ND	NA	No		
1,2-Dichloroethene	2.70E-01	7.00E-02	5/12	3/12	Yes	4.00E-03	1.29E-01	No		
Benzene	3.50E-02	5.00E-03	4/19	1/19	Yes	6.00E-03	8.36E-03	No		
Chloroform	1.40E-02	6.20E-03	3/19	1/19	Yes	ND	9.63E-03	No		
Tetrachloroethene	1.10E-01	5.00E-03	10/19	10/19	Yes	4.75E-02	1.91E-02	Yes	Yes	1.93E-01
Toluene	6.40E+00	1.00E+00	15/19	2/19	Yes	ND	2.46E+00	No		
Trichloroethene	1.10E+01	5.00E-03	14/19	14/19	Yes	5.70E-02	1.02E-02	Yes	Yes	4.26E-01
				Semivolatile organic compounds						
Bis(2-ethylhexyl)phthalate	2.60E-01	6.00E-03	4/4	4/4	Yes	1.95E+00	6.92E+00	No		
				Metals						
Arsenic	7.50E-03	1.00E-02	1/7	0/7	No	6.73E+00	NA	No		
Barium	4.71E+00	2.00E+00	8/8	2/8	Yes	ND	4.52E+02	No		
Thallium	3.10E-03	2.00E-03	1/8	1/8	Yes	1.95E-01	5.34E-01	No		
				Radionuclides						
Neptunium-237	ND	7.07E-01[b]			No	6.20E-02	NA	No		
Plutonium-239	ND	3.53E-01[b]			No	ND	NA	No		
Uranium-234	3.90E-01	2.00E+01[c]	1/4	0/4	No	1.27E+00	NA	No		
Uranium-238	3.00E-01	2.00E+01[c]	1/4	0/4	No	1.06E+00	NA	No		

[a]Highlighting indicates that the observed maximum groundwater concentrations exceed the MCL.
[b]The residential preliminary remediation goal at a risk level of 1E-06 was used as requested by the U. S. Environmental Protection Agency.
[c]Although an MCL for the individual uranium isotopes is not currently available, there is an MCL for total uranium, and the value in the table represents a derived MCL.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional Model.
COC = contaminant of concern.
C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level.
NA = not applicable.
ND = not detected.
RL = remediation level.
ROD = Record of Decision.
SESOIL = Seasonal Soil Compartment Model.

C.4.2.2 The C Area (Maintenance and Storage Area)

This area at K-1070-C was originally used as a burial ground. No records exist that specify the nature or quantity of materials that were buried. In late 1974 or early 1975, following completion of the landfill operations, K-1070-C became a maintenance equipment storage yard, and it is currently used to store uncontaminated maintenance equipment and materials. Potential non-point source contaminations include oil, solvents, and fuel that may have been spilled during general maintenance activities.

The COC selection process is the same as discussed for South Pits area in Section C.4.2. The contaminant concentrations in the groundwater of the immediate vicinity (i.e., UNW-115, UNW-017 and BRW-010) were screened against their respective MCL values.

In order to develop the CSM, the data for the bedrock geology in the K-1070-C trench area were used. The range of values for hydrogeologic properties used in the remediation level calculations is presented in Table C.10. The general direction of groundwater flow is southwest. The analytical soil data obtained for the COCs were used in a statistical analysis to develop the C_{SE} for the C area (Table C.11). The values were compared against the predicted remediation levels to determine if contaminant transport model (SESOIL and AT123D) simulations were needed for any contaminant. The two chemicals selected for the simulations of SESOIL and AT123D modeling were thallium and TCE. SESOIL simulation predicted that the thallium concentration will not reach groundwater within 1000 years – indicating soil cleanup for thallium is not necessary. Based on the AT123D predicted concentration of TCE in groundwater, the revised RL for TCE is 5.1 mg/kg, which is above its exposure point concentration. Therefore, soil cleanup for the protection of groundwater is not necessary for the C Area.

C.4.2.3 The K-1071 Concrete Pad Area

The K-1071 Concrete Pad area was used to crush scrap metal, empty drums and boxes in the early 1980s. During the RI (DOE 1995), the concrete pad was identified as an area with high radioactivity levels. Under a previous remedial action, approximately 2 feet of soil was placed on the concrete pad to prevent direct contact and provide shielding.

The hydrogeologic environment for the concrete pad area is the same as the C Area discussed in Section C.4.2.2. The general direction of groundwater flow is south. The COC selection process is the same as discussed for South Pits area. The contaminant concentrations in the groundwater of the immediate vicinity (i.e., BRW-094, BRW-097, and UNW-016) were screened against their respective MCL values. The groundwater contaminant summary is shown in Table C.12. As evident from the data, the only two chemicals that exceeded their respective MCL in groundwater are thallium and bis(2-ethylhexyl)phthalate. The analytical soil data obtained for these COCs were used in a statistical analysis to develop C_{SE} for the site (Table C.12). The values were compared against the predicted remediation levels to determine if contaminant transport model (SESOIL and AT123D) simulations were needed for any contaminant. Neither COC was selected for further consideration as their soil concentrations were below the remediation respective levels. Therefore, for the Concrete Pad Area, it may be concluded that soil cleanup for the protection of groundwater is not necessary.

C.4.3 K-1401 ACID LINES

The K-1401 building was used to perform cleaning operations for piping and other equipment and is located northwest of K-1070-C/D area. Cleaning methods included degreasing of equipment with carbon tetrachloride, trichloroethylene, caustics, and acids. These cleaning solutions were passed through the acid lines that were located on the northeast side of the building. These lines were the primary pathway for

Table C.10. Hydrogeologic parameters for developing remediation levels for groundwater protection in the C Area and Concrete Pad Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Parameter	Symbol	Units	Range of values (likeliest)	Comment
Percolation rate (vertical)	q_p	feet/day	7.00E-6 to 1.37E-3	Typical range for ETTP
Planar area of soil contamination	A_P	$feet^2$	43,560 to 1,346,000 (152,500)	Estimated from the map of South Pits area
Saturated hydraulic conductivity (overburden)	K_S	feet/day	7.3E-06 to 5.53 (0.67)	Based on field measurements for Rome Formations within ETTP
Saturated hydraulic conductivity (bedrock)	K_S	feet/day	3E-03 to 1.67	Based on field measurements for Rome Formations within ETTP
Horizontal hydraulic gradient (overburden)	I	unitless	8.3E-02 to 1.6E-01 (0.11)	Estimated from potentiometric map in the vicinity of the South Pits area
Horizontal hydraulic gradient (bedrock)	I	unitless	3E-03 to 9.5E-02 (0.05)	Typical range for Rome Formation in ETTP
Aquifer thickness (overburden)	h	feet	4.7 to 43.8	K-1070-C/D Site Summary Document
Aquifer thickness (bedrock)	h	feet	87.7 to 147	Typical range for Rome Formation in ETTP
Source width (perpendicular to flow)	w	feet	250	Estimated from map for the South pits contaminated area within K-1070-C/D area
Fraction organic carbon	f_{OC}	unitless	2.72E-3 to 8.83E-2	Site-specific measurements
Organic carbon distribution coefficient	K_{OC}	L/kg	constituent-specific	See Table C.4
Soil-water distribution coefficient	K_d	L/kg	constituent-specific	See Table C.3

ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

Table C.11. Summary of predicted soil remediation levels for groundwater protection based on MCLs for the C Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

ETTP Zone 2 COC	Maximum observed groundwater in K-1070-C/D C-Area[a] (mg/L, pCi/L)	MCL (mg/L, pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential groundwater COC?	Soil exposure concentration (C_{SE}) (mg/kg, pCi/g)	RLs based on 90th percentile (mg/kg, pCi/g)	C_{SE} > RL?	COCs selected for SESOIL and AT123D modeling	Revised RL (mg/kg, pCi/g)
				Volatile organic compounds						
1,1,1-Trichloroethane	3.00E-03	2.00E-01	4/12	0/12	No	0.0035	NA	NA		
1,1-Dichloroethene	4.40E-02	7.00E-03	7/12	2/12	Yes	NA	1.44E-02	No		
1,2-Dichloroethene	6.00E-01	7.00E-02	7/9	7/9	Yes	0.0124	1.52E-01	No		
Carbon tetrachloride	1.98E-02	5.00E-03	1/13	1/13	Yes	NA	1.75E-02	No		
Chloroform	6.13E-02	6.20E-03	3/13	2/13	Yes	NA	1.08E-02	No		
Tetrachloroethene	2.02E-01	5.00E-03	9/13	8/13	Yes	0.0137	2.64E-02	No		
Toluene	5.00E-03	1.00E+00	1/12	0/12	No	NA	NA			
Trichloroethene	1.60E+00	5.00E-03	11/13	11/13	Yes	0.0201	1.23E-02	Yes	Yes	5.10E+00
				Semivolatile organic compounds						
Bis(2-ethylhexyl)phthalate	4.90E-01	6.00E-03	3/3	3/3	Yes	0.08	1.09E+01	No		
				Metals						
Arsenic	1.70E-03	1.00E-02	2/5	0/5	No	7.23	NA	NA		
Barium	1.14E-01	2.00E+00	5/5	0/5	No	NA	NA	NA		
Lead	9.20E-04	1.50E-02	1/5	0/5	No	54.8	NA	NA		
Thallium	9.80E-03	2.00E-03	2/5	2/5	Yes	0.699	4.92E-01	Yes	Yes	NR*
				Radionuclides						
Neptunium-237	ND	7.07E-01[b]			No	9.60E-02	NA	NA		
Plutonium-239	ND	3.53E-01[b]			No	2.80E-02	NA	NA		
Uranium-234	2.68E+00	2.00E+01[c]	3/3	0/3	No	1.35	NA	NA		
Uranium-238	9.50E-01	2.00E+01[c]	2/3	0/3	No	1.19	NA	NA		

[a]Highlighting indicates that the observed maximum groundwater concentrations exceed the MCL.
[b]The residential preliminary remediation goal at a risk level of 1E-06 was used as requested by the U. S. Environmental Protection Agency.
[c]Although an MCL for the individual uranium isotopes is not currently available, there is an MCL for total uranium, and the value in the table represents a derived MCL.
NR* indicates that a remediation level is not required for the COC as it is not expected to reach the water table within 1000 years.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional Model.
COC = contaminant of concern.
C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level.
NA = not applicable.
ND = not detected.
RL = remediation level.
ROD = Record of Decision.
SESOIL = Seasonal Soil Compartment Model.

Table C.12. Summary of groundwater contaminants for the Concrete Pad Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

ETTP Zone 2 COC	Maximum observed groundwater in K-1070-C/D South Pits[a] (mg/L, pCi/L)	MCL (mg/L, pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential groundwater COC?	Soil exposure concentration (C_{SE}) (mg/kg, pCi/g)	RLs based on 90th percentile (mg/kg, pCi/g)	C_{SE} > RL?	COCs selected for SESOIL and AT123D modeling	Revised RL (mg/kg, pCi/g)
				Volatile organic compounds						
1,2-Dichloroethene	3.00E-03	7.00E-02	2/6	0/6	No	6.93	NA	NA		
Toluene	2.00E-03	1.00E+00	1/6	0/6	No	ND	NA	NA		
				Semivolatile organic compounds						
Bis(2-ethylhexyl)phthalate	4.20E-01	6.00E-03	3/3	3/3	Yes	2.24	6.3	No		
				Metals						
Arsenic	3.70E-03	1.00E-02	1/6	0/6	No	5.88	NA	NA		
Barium	1.84E-01	2.00E+00	6/6	0/6	No	ND	NA	NA		
Lead	1.80E-03	1.50E-02	1/6	0/6	No	ND	NA	NA		
Thallium	4.30E-03	2.00E-03	2/6	2/6	Yes	0.227	0.46	No		
				Radionuclides						
Neptunium-237	ND	7.07E-01[b]			No	1.19	NA	NA		

[a]Highlighting indicates that the observed maximum groundwater concentrations exceed the MCL.
[b]The residential preliminary remediation goal at a risk level of 1E-06 was used as requested by the U. S. Environmental Protection Agency.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional Model.
COC = contaminant of concern.
C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level.
NA = not applicable.
ND = not detected.
ROD = Record of Decision.

transporting organic and inorganic degreasing liquids to the K-1407-A Neutralization Pit and the K-1407-B Holding Pond. The acid lines leaked, allowing liquids to seep through the joints and corrode the limestone around the pipes.

The COC selection process is the same as discussed for South Pits area in Section C.4.2. The contaminant concentrations in the groundwater in the wells of the immediate vicinity (i.e., UNW-52, -53, -55, -91, etc.) were screened against their respective MCL values.

In order to develop the CSM, data for the bedrock geology in the K-1401 acid lines area, in addition to the available soil and well data for the area, were used. The range of values for hydrogeologic properties used in the remediation level calculation is presented in Table C.13 with references. The general direction of groundwater flow is north toward Mitchell Branch. The analytical soil data obtained for the COCs were used in a statistical analysis to develop the C_{SE} for the area (Table C.14). The values were compared against the predicted remediation levels to determine if contaminant transport model (SESOIL and AT123D) simulations were needed for any contaminant. The chemicals selected for the simulations of SESOIL and AT123D models' were 1,1-dichloroethene, 1,2-dichloroethene, trichloroethylene, and thallium. SESOIL simulation predicted that the thallium concentration will not reach groundwater within 1000 years – indicating soil cleanup for thallium is not necessary. Based on the AT123D predicted concentration of the organic compounds in groundwater, the revised RL values are shown in Table C.14. As indicated in Table C.14, the respective RL values are above their exposure point concentrations. Therefore, soil cleanup for the protection of groundwater is deemed unnecessary for the K-1401 Area.

Table C.13. Hydrogeologic parameters for developing remediation levels for groundwater protection in the K-1401 Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

Parameter	Symbol	Units	Range of values (likeliest)	Comment
Percolation rate (vertical)	q_p	feet/day	7.00E-6 to 1.37E-3	Typical range for ETTP
Planar area of soil contamination	A_P	feet^2	43,560 to 1,346,000 (152,500)	Estimated from the map of South Pits area
Saturated hydraulic conductivity (overburden)	K_S	feet/day	7.3E-06 to 5.53E-01	Based on field measurements for Rome Formations within ETTP
Saturated hydraulic conductivity (bedrock)	K_S	feet/day	3E-03 to 1.67	Based on field measurements for Rome Formations within ETTP
Horizontal hydraulic gradient (overburden)	I	unitless	3.57E-03 to 1.25E-02	Estimated from potentiometric map in the vicinity of the South Pits area
Horizontal hydraulic gradient (bedrock)	I	unitless	3.57E-03 to 1.25E-03	Typical range for Rome Formation in ETTP
Aquifer thickness (overburden)	h	feet	4.7 to 43.8	K-1070-C/D Site Summary Document
Aquifer thickness (bedrock)	h	feet	87.7 to 147	Typical range for Rome Formation in ETTP
Source width (perpendicular to flow)	w	feet	250	Estimated from map for the South pits contaminated area within K-1070-C/D area
Fraction organic carbon	f_{OC}	unitless	2.0E-4 to 1.4E-2 (3.55E-03)	Site-specific measurements
Organic carbon distribution coefficient	K_{OC}	L/kg	constituent-specific	See Table C.4
Soil-water distribution coefficient	K_d	L/kg	constituent-specific	See Table C.3

ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

Table C.14. Summary of predicted soil remediation levels for groundwater protection based on MCLs for the K-1401Area in ETTP Zone 2, Zone 2 ROD, Oak Ridge, Tennessee

ETTP Zone 2 COC	Maximum observed groundwater in K-1070-C/D South Pits[a] (mg/L, pCi/L)	MCL (mg/L, pCi/L)	Frequency of detect	Frequency of MCL exceedances	Potential groundwater COC?	Soil exposure concentration (C_{SE}) (mg/kg, pCi/g)	RLs based on 90th percentile (mg/kg, pCi/g)	C_{SE} > RL?	COCs selected for SESOIL and AT123D modeling	Revised RL (mg/kg, pCi/g)
				Volatile organic compounds						
1,1-Dichloroethene	3.90E-02	7.00E-03	12/47	8/47	Yes	9.64E-03	5.795E-03	Yes	Yes	1.69E-01
1,2-Dichloroethene	4.50E+00	7.00E-02	27/36	17/36	Yes	7.48E-02	5.213E-02	Yes	Yes	5.82E-01
Benzene	5.00E-03	5.00E-03	3/47	0/47	Yes	ND	NA	NA		
Carbon tetrachloride	3.00E-03	5.00E-03	1/47	0/47	No	ND	NA	NA		
Chloroform	5.00E-03	6.20E-03	7/47	0/47	No	ND	NA	NA		
Tetrachloroethene	1.00E-03	5.00E-03	1/47	0/47	No	1.50E-02	NA	NA		
Toluene	5.00E-03	1.00E+00	3/47	0/47	No	ND	NA	NA		
Trichloroethene	5.50E+00	5.00E-03	39/47	34/47	Yes	1.18E+00	4.281E-03	Yes	Yes	1.18E+01
Vinyl chloride	2.80E-01	2.00E-03	29/47	28/47	Yes	ND	1.055E-03	NA		
				Semivolatile organic compounds						
Bis(2-ethylhexyl)phthalate	6.50E-01	6.00E-03	8/8	8/8	Yes	ND	NA	NA		
				Metals						
Antimony	2.97E-02	6.00E-03	7/22	2/22	Yes	5.20E-01	4.316E+00	No		
Arsenic	6.00E-04	1.00E-02	2/22	0/22	No	5.71E+00	NA	NA		
Barium	8.03E-01	2.00E+00	22/22	0/22	No	ND	NA	NA		
Thallium	1.34E-02	2.00E-03	1/22	1/22	Yes	6.57E-01	2.168E-01	Yes	Yes	Not necessary
				Radionuclides						
Uranium-234	1.10E+00	2.00E+01[b]	8/16	0/16	No	1.10E+00	NA	NA	0/16	
Uranium-238	9.40E-01	2.00E+01[b]	2/16	0/16	No	7.39E-01	NA	NA	0/16	

[a]Highlighting indicates that the observed maximum groundwater concentrations exceed the MCL.
[b]Although an MCL for the individual uranium isotopes is not currently available, there is an MCL for total uranium, and the value in the table represents a derived MCL.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional Model.
COC = contaminant of concern.
C_{SE} = soil exposure concentration.
ETTP = East Tennessee Technology Park.
MCL = maximum contaminant level
NA = not applicable.
ND = not detected.
RL = remediation level.
ROD = Record of Decision.
SESOIL = Seasonal Soil Compartment Model.

DISTRIBUTION

File–EMEF DMC–RC

C.5. REFERENCES

Baes, C. F., et al. 1984. *A Review of Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, TN.

DOE (U. S. Department of Energy) 1995. *Phase 2 Remedial Investigation/Baseline Risk Assessment Report and Feasibility Study for the K-1070-C/D Classified Burial Ground at the Oak Ridge K-25 Site*, DOE/OR/01-1297&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1996. *Remedial Investigation of Bear Creek Valley at the Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1455&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1997. *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*, DOE/OR/01-1455/V1&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1998. *Remedial Investigation Report for East Tennessee Technology Park. Oak Ridge, Tennessee*, DOE/OR/01-1297&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999a. *Remedial Investigation/Feasibility Study for Bethel Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1748/V1&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 1999b. *Remedial Investigation Report for the East Tennessee Technology Park, Oak Ridge, Tennessee*, Vol. 1, DOE/OR/01-1778/V1-6&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2000. *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1964&D1, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2002. *Record of Decision for Interim Actions in Bethel Valley, Oak Ridge, Tennessee*, DOE/OR-1862&D4, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE 2003. *Upper East Fork Poplar Creek Soil and Scrapyard Focused Feasibility Study*, DOE/OR/2083&D2, U. S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

Energy Systems (Martin Marietta Energy Systems, Inc.) 1995. *Results of Slug Tests Conducted at Monitoring Wells at the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, K/ER/252, Martin Marietta Energy Systems, Inc., Environmental Restoration Program, Oak Ridge, TN.

EPA (U. S. Environmental Protection Agency) 1994. *Risk Reduction Engineering Laboratory (RREL) Treatability Database*, Version 5.0, U. S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH.

EPA 1995. *Land Use in CERCLA Remedy Selection Process*, OSWER Directive No. 9355.7-04, U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA 1996. *Soil Screening Guidance: Technical Background Document*, 2nd ed., EPA/540/R-95/128, U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Hatcher, R. D., Jr., et al. 1992. *Status Report on the Geology of the Oak Ridge Reservation*, ORNL/TM-12074, Oak Ridge National Laboratory, Oak Ridge, TN.

MMES (Martin Marietta Energy Systems, Inc.) 1994. *Geological Mapping of the Oak Ridge K-25 Site, Oak Ridge, Tennessee*, K/ER-111, Martin Marietta Energy Systems, Inc., Environmental Restoration Program, Oak Ridge, TN.

Moore, G. K. 1992. *Groundwater Parameters and Flow Systems Near Oak Ridge National Laboratory*, ORNL/TM-11368, Oak Ridge National Laboratory, Oak Ridge, TN.

Sheppard, M. I., and Thibault, D. H. 1990. "Default Soil Solid/Liquid Partition Coefficients for Four Major Soil Types: A Compendium," *Health Phys.* 59(4): 471–482.

Summers, K. S., Gherini, S., and Chen, C. 1980. *Methodology to Evaluate the Potential for Groundwater Contamination from Geothermal Fluid Release*, EPA-600/7-80-117, as modified by U. S. Environmental Protection Agency, Region 4.